

Western University
Faculty of Engineering
Department of Civil and Environmental Engineering

CEE 9675 – Modeling and Simulation of Wastewater Systems

COURSE OUTLINE 2024-2025

DESCRIPTION

The course includes an overview of wastewater treatment systems' state-of-the-art modelling and simulation approaches. This course will introduce students to wastewater systems, including sewer networks, wastewater characteristics, and fundamental biological, chemical, and physical process modelling concepts for removing water pollutants. Students will model sewer networks and different unit processes to elucidate the functioning of processes, communicate knowledge about the system's performance, and recognize the models' limitations and uncertainty. Students will acquire hands-on experience with simulation methods supported with state-of-the-art software(s) that include commercial and open-source, model-based design, optimization, and control of wastewater flow and processes.

PREREQUISITES

CEE 3362a/b or CBE 4409a/b or comparable courses with permission from the instructor.

This course is intended for civil and environmental or chemical engineering graduate students interested in water/wastewater infrastructure. Students must understand water/wastewater engineering by taking suitable undergraduate or graduate courses.

TOPICS

Topic #	Description	Learning Activities	Tentative timeline
Part I	Lesson 1: Sanitary Sewer Design	<ul style="list-style-type: none">• One Lecture (3 hours)• One computer lab session (Openflows SewerCAD)• Additional reading material• Assignment-1	Week 1
	Lesson 2: Wastewater Characterization for Modelling Purposes	<ul style="list-style-type: none">• One Lecture• One computer lab session (SUMO)• Additional reading material• Assignment-2	Week 2
	Lesson 3: Headworks Hydraulics and Preliminary Treatment	<ul style="list-style-type: none">• One Lecture• One Tutorial: Problem-Solving	Week 3

		<ul style="list-style-type: none"> • Additional reading material 	
	Lesson 4: Pretreatment	<ul style="list-style-type: none"> • One Lecture • One computer lab, SUMO • Additional reading material • Assignment-3 	Weeks 4
Part 2	Lesson 5: Mathematical modelling of biological phenomena/Wastewater Microbiology a. Kinetics b. Stoichiometry c. Mass balance d. Hydraulics e. Matrix notations	<ul style="list-style-type: none"> • Two lectures • One computer lab, Process model introduction, SUMO • One tutorial session • Additional reading material • Assignment-4 	Weeks 5 and 6
	Lesson 6: Good modelling practice a. Data quality b. Calibration and validation processes c. Sensitivity analysis, parameter, and model structure uncertainty	<ul style="list-style-type: none"> • One Guest Lecture • One computer lab session (SUMO) • One tutorial session 	Week 7
	Lesson 7: Overview of suspended biological processes DO models and other process models: a. Organic modelling b. Nitrification modelling c. Denitrification modelling d. Biological P removal processes modelling e. Other models (AD or biofilm model	<ul style="list-style-type: none"> • Five lectures • Five computer lab sessions • Assignment 5 • Assignment 6 	Weeks 8 – 12

Note:

Attendance in lectures and computer labs and the timely completion of all assignments is MANDATORY.

Please note that there will be no class during reading week (February 17-25th).

SPECIFIC LEARNING OUTCOMES

Degree Level Expectation	Weight	Assessment Tools	Outcomes
Depth and breadth of knowledge	25%	<ul style="list-style-type: none"> • Assignments • Project 	<ul style="list-style-type: none"> • Understanding of advanced concepts and theories • Awareness of critical current problems in the field of study • Understanding of computational and empirical methodologies to solve related problems
Research & Scholarship	15%	<ul style="list-style-type: none"> • Project 	<ul style="list-style-type: none"> • Ability to conduct a critical evaluation of current advancements in the field of specialization • Ability to conduct coherent and thorough analyses of complex problems using established techniques/principles and judgment
Application of knowledge	30%	<ul style="list-style-type: none"> • Assignments • Project 	<ul style="list-style-type: none"> • Ability to apply knowledge in a rational way to analyze a particular problem • Ability to use a coherent approach to design a particular engineering system using existing design tools
Professional capacity/autonomy	5%	<ul style="list-style-type: none"> • Project 	<ul style="list-style-type: none"> • Awareness of academic integrity • Ability to implement established procedures and practices in the coursework • Defends own ideas and conclusions • Integrates reflection into their learning process
Communication skills	15%	<ul style="list-style-type: none"> • Project 	<ul style="list-style-type: none"> • Ability to communicate (oral and written) ideas, issues, results and conclusions clearly and effectively
Awareness of limits of knowledge	10%	<ul style="list-style-type: none"> • Project 	<ul style="list-style-type: none"> • Awareness of the need for assumptions in complex scientific analyses and their consequences • Understanding of the difference between theoretical and empirical approaches • Ability to acknowledge analytical limitations due to the complexity of practical problems

ASSESSMENTS

Assessment Type	Material Covered	Tentative Due Date	Weight
Assignments (Six)	All (See TOPICS)	Weeks 1 to 11	45%
Project Presentation		Week 12	25%
Project Report		Week 12	10%
Final Exam		Week 13 - 14	20%

Activities in which collaboration is permitted:

- Assignments

Activities in which students must work alone (collaboration is not permitted):

- Project-related work

CONTACT HOURS

Three lecture hours per week and 2 hours per week of computer lab/tutorial will be delivered in person. Attendance of the **computer lab and lecture sessions is mandatory**. Students are responsible for regularly checking their email and the course OWL site for new notices, forum discussions, and resources related to the course. All communication will be through OWL.

CONTACT INFORMATION

Course instructor: Martha Dagnev

Email address: mdagnev@uwo.ca

Contact policy:

- Contact the instructor via email (above) or through messages in OWL
- A general FAQ section on the 'forums' section of OWL will be used for students to pose course-related questions so that all have the same information.

COMPUTING

Assignments will require data processing using computer data-analysis software such as Matlab, Excel, or other tools. Students will be assumed to be proficient in using the software of their choice. Commercial wastewater simulation software will be used during the course. Students can use open-source or commercial software to complete their projects and assignments. Students will use Western's IT service to access online simulation software.

REQUIRED REFERENCE BOOK

- Water and Wastewater Engineering: Design Principles and Practice, Davis, M. 2020
- Grady, C.P.L, Daigger, G.T., Love, N.G. and Filipe, C.D.M. 2011. Biological wastewater treatment. IWA publishing
- Biological wastewater treatment: principles, modelling, and design. 2008. IWA

OPTIONAL COURSE READINGS

- Guidelines for using activated sludge models. 2012. IWA Publishing, London, UK.
- Methods for wastewater characterization in activated sludge modelling. 2003. WEF

COURSE CONTENT

The lecture notes and online lecture videos are copyrighted to the instructor and legally protected. Do not post these videos and lecture notes on other websites or online forums. The recording of the live/synchronous sessions of the course without permission from the instructor is prohibited. The illegal posting and sharing of the copyrighted course content could be subjected to legal action.

CHEATING, PLAGIARISM/ACADEMIC OFFENCES

Academic integrity is an essential component of learning activities. Students must have a clear understanding of the course activities in which they are expected to work alone (and what working alone implies) and the activities in which they can collaborate or seek help; see information above and ask instructor for clarification if needed. Any unauthorized forms of help-seeking or collaboration will be considered an academic offense. University policy states that cheating is an academic offence. If you are caught cheating, there will be no second warning. Students must write their essays and assignments in their own words. Whenever students take an idea or a passage of text from another author, they must acknowledge their debt both by using quotation marks where appropriate and by proper referencing such as footnotes or citations. Plagiarism is a major academic offence. Academic offences are taken seriously and attended by academic penalties which may include expulsion from the program. Students are directed to read the appropriate policy, specifically, the definition of what constitutes a Scholastic Offence at the following website: https://www.uwo.ca/univsec/pdf/academic_policies/appeals/scholastic_discipline_grad.pdf

All required papers may be subject to submission for textual similarity review to the commercial plagiarism-detection software under license to the University for the detection of plagiarism. All papers submitted for such checking will be included as source documents in the reference database for the purpose of detecting plagiarism of papers subsequently submitted to the system. Use of the service is subject to the licensing agreement, currently between The University of Western Ontario and Turnitin.com (<http://www.turnitin.com>).

CONDUCT

Students are expected to follow proper etiquette to maintain an appropriate and respectful academic environment. Any student who, in the opinion of the instructor, is not appropriately participating in course activities and/or is not following the rules and responsibilities associated with the course activities, will be reported to the Associate Dean (Graduate) (after due warning has been given). On the recommendation of the Department concerned, and with the permission of the Associate Dean (Graduate), the student could be debarred from completing the assessment activities in the course as appropriate.

HEALTH/WELLNESS SERVICES

As part of a successful graduate student experience at Western, we encourage students to make their health and wellness a priority. Western provides several health and wellness related services to help you achieve optimum health and engage in healthy living while pursuing your graduate degree. Information regarding health- and wellness-related services available to students may be found at <http://www.health.uwo.ca/>.

Students seeking help regarding mental health concerns are advised to speak to someone they feel comfortable confiding in, such as their faculty supervisor, their program director (graduate chair), or other relevant administrators in their unit. Faculty of Engineering has a Student Wellness Counsellor. Information on how to schedule an appointment with the counsellor is available at: <https://www.eng.uwo.ca/undergraduate/academic-support-and-accommodations/Student-Wellness-Counselling.html>

Students who are in emotional/mental distress should refer to Mental Health@Western: <http://www.uwo.ca/uwocom/mentalhealth/> for a complete list of options about how to obtain help.

SICKNESS

Students should immediately consult with the Instructor (for a particular course) or Associate Chair (Graduate) (for a range of courses) if they have problems that could affect their performance. The student should seek advice from the Instructor or Associate Chair (Graduate) regarding how best to deal with the problem. Failure to notify the Instructor or the Associate Chair (Graduate) immediately (or as soon as possible thereafter) will have a negative effect on any appeal. Obtaining appropriate documentation (e.g., a note from the doctor) is valuable when asking for accommodation due to illness.

Students who are not able to meet certain academic responsibilities due to medical, compassionate or other legitimate reason(s), could request for academic consideration. The Graduate Academic Accommodation Policy and Procedure details are available at:

<https://www.eng.uwo.ca/graduate/current-students/academic-support-and-accommodations/index.html>

ACCESSIBLE EDUCATION WESTERN (AEW)

Western is committed to achieving barrier-free accessibility for all its members, including graduate students. As part of this commitment, Western provides a variety of services devoted to promoting, advocating, and accommodating persons with disabilities in their respective graduate program. Graduate students with disabilities (for example, chronic illnesses, mental health conditions, mobility impairments) are strongly encouraged to register with Accessible Education Western (AEW): http://academicsupport.uwo.ca/accessible_education/index.html

AEW is a confidential service designed to support graduate and undergraduate students through their academic program. With the appropriate documentation, the student will work with both AEW and their graduate programs (normally their Graduate Chair and/or Course instructor) to ensure that appropriate academic accommodations to program requirements are arranged. These accommodations include individual counselling, alternative formatted literature, accessible campus transportation, learning strategy instruction, writing exams and assistive technology instruction.

STATEMENT ON THE USE OF GENERATIVE ARTIFICIAL INTELLIGENCE (AI)

The use of AI in the preparation of the project and assignments must be acknowledged in the submission. Please refer to the published [Provisional Guidance for the Use of Generative AI in Graduate Studies](#) at Western University.