DESCRIPTION
The course includes an overview of wastewater treatment systems' state-of-the-art modelling and simulation approaches. This course will introduce students to fundamental biological, chemical, and physical process modelling concepts for removing water pollutants. Students will model 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 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 treatment. Students are expected to have a basic understanding of water/wastewater treatment fundamentals obtained by taking suitable undergraduate or graduate courses. Students without a proper water/wastewater treatment background shall be permitted to enroll only at the course instructor's discretion.

TOPICS

<table>
<thead>
<tr>
<th>Topic #</th>
<th>Description</th>
<th>Learning Activities</th>
<th>Tentative timeline</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Part 1</strong></td>
<td>Fundamentals</td>
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</table>
| | Lesson 1: Wastewater treatment overview and Introduction to the simulation platform | • Three lectures  
• One computer lab session (week 2)  
• One tutorial session (week 3)  
• Additional reading material | Weeks 1, 2 and 3 |
| | Lesson 2: Mathematical modelling of biological phenomena  
  a. Kinetics  
  b. Stoichiometry  
  c. Mass balance  
  d. Hydraulics  
  e. Matrix notations | • Two lectures  
• One computer lab session (week 4)  
• One tutorial session (week 5)  
• Additional reading material  
• Assignment-1 | Weeks 4 and 5 |
Lesson 3: Good modelling practice  
a. Data quality  
b. Calibration and validation processes  
c. Sensitivity analysis, parameter, and model structure uncertainty  

- One lecture (week 6)  
- One computer lab session (week 6)  
- One tutorial session (week 7)  
- Assignment 2  

Part II  
Lesson 4: Overview of activated sludge, clarifier, and DO models and anaerobic digestion models  
a. Soluble and particulate organic modelling  
b. Clarifier and aeration models  
c. Nitrification modelling  
d. Total nitrogen process modelling,  
e. P removal processes  
f. Process control  
g. Other models (AD or biofilm model)  

- Four lectures  
- Three computer lab sessions  
- Three tutorial sessions  
- Assignment 3  
- Assignment 4  
- Assignment 5  

Part III  
Lesson 5: Case studies - Scenario analysis with real-world modelling objectives and real datasets  

- one lecture  

Weeks 6, 7

Weeks 7 – 11

Weeks 12

Note:  
1. Attendance of lectures and computer labs is required. Anyone who cannot attend classes, computer labs and tutorial sessions should speak with the instructor to find an acceptable solution.  
2. Please note that there will be no class during reading week

### SPECIFIC LEARNING OUTCOMES

<table>
<thead>
<tr>
<th>Degree Level Expectation</th>
<th>Weight</th>
<th>Assessment Tools</th>
<th>Outcomes</th>
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<tbody>
<tr>
<td>Depth and breadth of knowledge</td>
<td>25%</td>
<td>Assignments, Project</td>
<td>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</td>
</tr>
<tr>
<td>Research &amp; Scholarship</td>
<td>15%</td>
<td>Project</td>
<td>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</td>
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</table>
Application of knowledge 30%
- Assignments
- Project
- 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%
- Project
- 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%
- Project
- Ability to communicate (oral and written) ideas, issues, results and conclusions clearly and effectively

Awareness of limits of knowledge 10%
- Project
- 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

<table>
<thead>
<tr>
<th>Assessment Type</th>
<th>Material Covered</th>
<th>Tentative Due Date</th>
<th>Weight</th>
</tr>
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<tbody>
<tr>
<td>Assignments (five)</td>
<td>Lessons 1, 2, 3 and 4</td>
<td></td>
<td>40%</td>
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<tr>
<td>In-class problem-solving and participation</td>
<td>Lessons 1, 2, 3 and 4</td>
<td></td>
<td>10%</td>
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<tr>
<td>Project proposal submission</td>
<td></td>
<td>Week 7</td>
<td>10%</td>
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<tr>
<td>Project final presentation</td>
<td></td>
<td>Week 13</td>
<td>20%</td>
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<tr>
<td>Project report submission</td>
<td></td>
<td>Week 14</td>
<td>20%</td>
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**Activities in which collaboration is permitted:**
- Assignments and in-class exercises

**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. The 2 hours per week lab/tutorial session will run alternatively and will be used for either hands-on computer lab simulations or will be used for tutorial sessions. 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 Dagnew
Email address: mdagnew@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 TEXTBOOK
• Biological wastewater treatment: principles, modelling, and design. 2008. IWA

OPTIONAL COURSE READINGS
• 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 any other website 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 clearly understand 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 the information above under “Assessments” and ask the instructor for clarification if needed. Any unauthorized forms of help-seeking or collaboration will be considered an academic offence. 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 from another author, they must acknowledge their debt by using quotation marks where appropriate and proper referencing, such as footnotes or citations. Plagiarism is a major academic offence. Academic offences are taken seriously and attended to 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 (see Western's scholastic discipline regulations for graduate students).
SYNCHRONOUS LEARNING ACTIVITIES
Students are expected to participate in synchronous learning activities as outlined in the course syllabus and described by the instructor. If you have issues that will impede your ability to participate in synchronous activities, please discuss them with the course instructor at the beginning of the course.

CONDUCT
Students must follow proper etiquette during synchronous and asynchronous activities to maintain an appropriate and respectful academic environment. Any student who, in the opinion of the instructor, is not appropriately participating in the synchronous and asynchronous learning activities and is not following the rules and responsibilities associated with the online learning 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
As part of a successful graduate student experience at Western, we encourage students to prioritize their health and wellness. Western provides several health and wellness-related services (remotely accessible) 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, program director (graduate chair), or other relevant administrators in their unit. Campus mental health resources may be found at http://www.health.uwo.ca/mental_health/resources.html https://www.uwo.ca/health/psych/index.html.

SICKNESS
Students should immediately consult with the instructor (for a particular course) or Associate Chair (Graduate) (for a range of techniques) 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 situation. Failure to notify the Instructor or the Associate Chair (Graduate) immediately (or as soon as possible after that) will hurt any appeal. Obtaining appropriate documentation (e.g., a note from the doctor) is valuable when asking for accommodation due to illness.

ACCESSIBILITY
Please get in touch with the course instructor if you require material in an alternate format or if any other arrangements can make this course more accessible to you. You may also wish to contact Accessible Education at 661-2111 x 82147 or http://academicsupport.uwo.ca/accessible_education/index.html for any specific questions regarding accommodation.