

**Western University - Faculty of Engineering**  
Department of Civil and Environmental Engineering

CEE 4463B – Watershed Modelling  
Course Outline – Winter 2025

**DESCRIPTION**

This course introduces students to the concepts, techniques and application of few widely used software tools to process watershed and simulate flood hazard characteristics. Students will develop an understanding of Geographic Information System (GIS) to analyze spatial hydrologic datasets and conduct hydrologic and hydraulic modelling using HEC-HMS, HEC-GeoHMS, HEC-RAS, HEC-GeoRAS and ArcGIS modules. By the end of this course, students should be able to:

- Identify, describe, and convert between common geospatial data types in a GIS;
- Explain, transform and manipulate map projections and coordinate systems;
- Identify, describe and perform various kinds of basic spatial analyses beneficial in water resources system modelling;
- Accurately digitize riverine features in a GIS for use in hydrologic and hydraulic modeling software;
- Competently use spatial modeling, hydrologic and hydraulic software tools for water resources applications [ET3];
- Apply fundamental principles of hydrology and hydraulics for river network analysis [ET3];
- Apply knowledge of spatial data, processes, and analysis combined with hydrologic and hydraulic tools to find solutions to common water resources management problems [ET3];
- Effectively present results of analyses in both oral and written formats.

**TOPICS**

<b>Topic #</b>	<b>Description</b>	<b>Tentative timeline</b>
1	Introduction to GIS applications in water resources management	Week 1
2	Fundamentals of vector and raster data types and GIS modeling in water resources management	Week 2
3	Development and editing TIN and DEM terrain	Week 3
4	Understanding basic hydrology functionality within ArcMap	Weeks 4-5
5	Terrain processing, watershed delineation and stream network analysis	Weeks 6-7
6	Hydrologic modeling using HEC-HMS and HEC-GeoHMS	Weeks 8-9

7	Hydraulic Modeling and floodplain mapping using HEC-RAS and HEC-GeoRAS	Weeks 10-11
8	Term project presentations and discussions	Week 12

**Note:** The instructor may expand, or revise material presented in the course as appropriate.

### **SPECIFIC LEARNING OUTCOMES**

<b>Degree Level Expectation</b>	<b>Weight</b>	<b>Assessment Tools</b>	<b>Outcomes</b>
<b>Depth and breadth of knowledge</b>	25%	<ul style="list-style-type: none"> <li>• Assignments</li> <li>• Project</li> <li>• Examination</li> </ul>	<ul style="list-style-type: none"> <li>• Understanding of hydrologic and hydraulic modelling software tools for watershed modelling</li> <li>• Awareness of important current problems in the application of spatial data and GIS as a tool to support water resources management</li> <li>• Understanding of flood modelling approaches to solve related problems</li> </ul>
<b>Research &amp; scholarship</b>	15%	<ul style="list-style-type: none"> <li>• Project</li> </ul>	<ul style="list-style-type: none"> <li>• Ability to conduct critical evaluation of current advancements in watershed modelling</li> <li>• Ability to conduct coherent and thorough analyses of complex problems using established techniques/principles, software tools and judgment</li> </ul>
<b>Application of knowledge</b>	30%	<ul style="list-style-type: none"> <li>• Assignments</li> <li>• Project</li> <li>• Examinations</li> </ul>	<ul style="list-style-type: none"> <li>• Ability to apply knowledge in a rational way to analyze a particular problem</li> <li>• Ability to use coherent approach to characterize a particular engineering system using existing modelling and design tools</li> </ul>
<b>Professional capacity / autonomy</b>	5%	<ul style="list-style-type: none"> <li>• Project</li> </ul>	<ul style="list-style-type: none"> <li>• Awareness of academic integrity</li> <li>• Ability to implement established procedures and practices in the coursework</li> <li>• Defends own ideas and conclusions</li> <li>• Integrates reflection into his/her learning process</li> </ul>
<b>Communication skills</b>	15%	<ul style="list-style-type: none"> <li>• Project</li> </ul>	<ul style="list-style-type: none"> <li>• Ability to communicate (oral and/or written) ideas, issues, results and conclusions clearly and effectively</li> </ul>

<b>Awareness of limits of knowledge</b>	10%	<ul style="list-style-type: none"> <li>• Project</li> </ul>	<ul style="list-style-type: none"> <li>• Awareness of the need of assumptions in complex scientific analyses and their consequences</li> <li>• Understanding of the difference between theoretical and empirical approaches</li> <li>• Ability to acknowledge analytical limitation due to complexity of practical problems</li> </ul>
---	-----	---	--

### **PREREQUISITE**

Earth Sciences 3340A/B

This course is designed for undergraduate and graduate students enrolled in civil engineering, environmental science, statistics and geography with an interest in data analysis, interpretation, and modelling. It is expected that students will have basic understanding of hydrology and hydraulics by taking suitable courses at the undergraduate or graduate levels. Students without a suitable background in these topics should consult with the instructor prior to registering for the course.

### **COREQUISITES**

None.

### **ANTIREQUISITES**

CEE 4429A/B (if taken before 2020) for undergraduate students.

Note: It is the student's responsibility to ensure that all Prerequisite conditions are met or that special permission to waive these requirements has been granted by the Faculty. It is also the student's responsibility to ensure that he/she has not taken a course listed as an Antirequisite.

The student may be dropped from the course or not given credit for the course towards his/her degree if he/she violates the Prerequisite, Corequisite or Antirequisite conditions.

### **INSTRUCTOR**

M. Reza Najafi, PhD, PEng  
 Claudette MacKay-Lassonde Pavilion  
 Room 1301  
 Email: mnajafi7@uwo.ca

### **CONTACT HOURS**

2 lecture hours per week.

A 2-hour tutorial session will be delivered during the scheduled tutorial hours. Tutorials are mandatory and students seeking assistance with weekly assignments or clarification on lecture material are strongly encouraged to attend.

## **COURSE MATERIALS**

Prepared class notes by Dr. Najafi covering the material will be posted on OWL

References (optional):

- GIS Fundamentals: A first text on Geographic Information Systems, 4th (or 3rd) Edition; Paul Bolstad, Eider Press, 2012 (2008)
- Maidment, David R., Arc Hydro: GIS for Water Resources, ESRI Press, 2002.
- Engineering Hydrology: An Introduction to Processes, Analysis, and Modeling, Jain and Singh, McGraw-Hill Education; 1 edition, 2019
- Hydrology: An Introduction, Wilfried Brutsaert, Cambridge University Press, 2023
- HEC-RAS User's Manual, Hydrologic Engineering Center, 2023.
- HEC-HMS Hydrologic Modeling System, User's Manual, Hydrologic Engineering Center, 2016

## **COMPUTING**

Assignments and term project will require several software tools including ArcGIS and related hydrologic extensions, HEC-HMS and HEC-RAS. Students are required to become proficient in the use of the software. All software environments used in this class are either freely available or can be accessed remotely through Western Technology Services

<https://wts.uwo.ca/sitelicense/index.html>

## **UNITS**

SI units will be used in lectures and examinations.

## **GENERAL LEARNING OBJECTIVES**

E=Evaluate, T=Teach, I=Introduce

Problem Analysis	T	Team Work	T	Ethics and Equity	
Investigation		Communication	T	Economics and Project Management	
Design	T	Professionalism		Life-Long Learning	T
Engineering Tools	T	Impact on Society	T	Knowledge Base	T

## **ASSIGNMENTS AND PROJECT**

There will be five assignments spaced throughout the course. The project will span the length of the course and will involve setting up a hydrologic and a hydraulic model for a given watershed and analyzing the flood hazards.

## **EXAMINATION**

A two-hour written final examination will be held during the regular examination period. The exam will be conducted online by using randomized questions via the OWL platform.

The written examination will be followed by a 15-minute oral examination in which the written examination will be reviewed and discussed with the student.

## **ASSESSMENTS**

The final course mark will be determined as follows:

Final Exam	20%
Assignments:	40%
Project:	30%
Participation:	10%
	-----
Total	100%

### **Note:**

**(a) Students must turn in all individual assignments and projects to pass this course.**  
Students who do not satisfy this requirement will be assigned 48% or the aggregate mark, whichever is less.

**(b) Students who have failed this course previously must repeat all components of the course.** No special permissions will be granted enabling a student to retain laboratory, assignment or test marks from previous years. Previously completed assignments and laboratories cannot be resubmitted.

**(c)** Should any of the quizzes conflict with a religious holiday that a student wishes to observe, the student must inform the instructor of the conflict no later than two weeks before the scheduled test.

(For further information on Accommodations for Religious Holidays see [https://www.uwo.ca/univsec/pdf/academic\\_policies/appeals/accommodation\\_religious.pdf](https://www.uwo.ca/univsec/pdf/academic_policies/appeals/accommodation_religious.pdf))

**(d)** Participation will be tracked through forum posts and discussions during lecture hours.

### **Activities in which collaboration is permitted:**

- Projects- Students within each group are encouraged to closely collaborate on their projects
- Assignments- Students are encouraged to ask their questions or provide hints to solve give problems using through the “Forums” tool on OWL. Students are not allowed to copy assignments, which will be considered as plagiarism.

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

- Final exam

## **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 the permission from the instructor is prohibited. The illegal posting and sharing of the copyrighted course content could be subjected to legal actions.

**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 under “Assessments” 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 (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/or described by the instructor. If you have issues that will impede your ability to participate in synchronous activities, please discuss with the course instructor at the beginning of the course.

**CONDUCT**

Students are expected to 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/or 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 make their health and wellness a priority. 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, their 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](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 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.

**ACCESSIBILITY**

Please contact 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](http://academicsupport.uwo.ca/accessible_education/index.html), for any specific question regarding an accommodation.

**AU**

Engineering Science 100%