

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

**CEE 4476a – Environmental Hydraulics Design - Course Outline 2023**

This course applies the principles of hydraulics and fluid mechanics to environmental flows of water in open channels. At the end of this course students will be able to:

- Identify, formulate, and analyze environmental hydraulics of open channel flows
- Apply knowledge of hydraulics and fluid mechanics to the analysis and design of hydraulic structures and river flows
- Plan, and design, and interpret the results of a laboratory investigation in support of a design project in a small group
- Improve communication skills by contributing to the preparation of comprehensive reports and an oral presentation
- Develop an awareness of water resources issues surrounding environmental flows in open channel waters, and appreciate professional responsibility issues
- Creatively solve problems individually and in small groups

**Calendar Copy:**

The application of hydraulic engineering principles in the analysis of environmental flows. Topics include: open channel transitions, flow measuring devices, stabilization of a natural river, flood control channels, spillways and stilling basins, culverts, and sediment transport in alluvial channels.

**Prerequisites:**

CEE 2224

**Antirequisites:**

None

Note: It is the student's responsibility to ensure that all Prerequisite and Corequisite 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 they have not taken a course listed as an Antirequisite. The student may be dropped from the course or not given credit for the course towards their degree if they violate the Prerequisite, Corequisite or Antirequisite conditions.

**Contact Hours:**

2 lecture hours, 1 laboratory hours, and 2 tutorial hours per week.  
Attendance at the tutorial/laboratory session is **mandatory**.

**Instructor:**

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Phone: ext. 86428

CEE Office SEB 3005 civil@uwo.ca

### **Textbook:**

The required text for this class is:

- Sturm, T. *Open Channel Hydraulics*, 3<sup>rd</sup> Edition. McGraw-Hill Higher Education, 2021. Can be purchased at the bookstore or Amazon.

### **Other References**

- Chanson H., *Hydraulics of Open Channel Flow*, 2nd Edition. Butterworth-Heinemann, 2004.
- Chanson H., *Environmental Hydraulics for Open Channel Flows*. Butterworth-Heinemann, 2004.
- French R., *Open Channel Hydraulics*. Water Resources Publications, 2007.
- Julien P., *Essentials of Hydraulics*. Cambridge University Press, 2022.

### **Active Engaged Classroom:**

It is important for the students to attend the class and actively participate in different activities that are set to encourage engaged learning. Web-browsing, texting, and social media are not allowed during class time as they will distract other students.

### **Units:**

Both SI and FPS unit systems may be used in lectures, tutorials and examinations.

### **Specific Learning Objectives [GA Indicator – bold denotes evaluated indicator]:**

#### 1. *Basic Principles* [PA1]

- Classify different types of flow regimes in open channel hydraulics
- Demonstrate an understanding of the important concepts in fluid mechanics (continuity, momentum and energy equations)

#### 2. *Specific Energy* [PA1]

- Describe and compute the specific energy diagram and critical depth in simple and complex channel cross-sections
- Apply the governing equations for open channel contractions and expansions with head loss
- Determine the discharge range of critical depths in overbank flow conditions
- Apply weirs in the design of open channel flow measuring devices
- Apply the energy equation in stratified flows

#### 3. *Momentum* [PA1, DE1]

- Apply the momentum equation in open channel flows for the analysis of hydraulic jumps
- Design a stilling basin to stabilize hydraulic jumps
- Analyze the occurrence of surges in open channel hydraulics
- Apply momentum analysis to backwater effects caused by flow obstructions

4. *Uniform Flow* [PA1, DE1]

- Describe the flow resistance in turbulent open channel flows and the resulting velocity distributions for various hydraulic conditions
- Compute uniform flow depth in simple and compound channels
- Design channels with flexible linings, flood control and flood diversion channels

5. *Gradually Varied Flow* [PA1, IN3, DE1]

- Describe gradually varied flows and apply the related equations
- Classify water surface profiles
- Compute water surface profiles in artificial and natural channels
- Use HEC-RAS to compute water surface profiles

6. *Hydraulic Structures* [PA1, IN2, **DE1**, DE2, **DE4**]

- Design spillways to transfer large flood discharges safely downstream from a reservoir
- Describe and apply methods for computing bridge backwater effects

7. *Unsteady Flow* [PA1, DE1]

- Describe the development and application of dynamic wave equations
- Apply the Saint-Venant equations to characterize unsteady flow conditions

8. *Flow in Alluvial Channels* [PA1, IN3, DE1, DE2, DE4]

- Compute the fall velocity of sediment in water for various conditions
- Determine the stability of the bed and banks of natural alluvial channels by evaluating the threshold of sediment movement
- Predict bed-load transport and the total sediment discharge of an alluvial stream
- Estimate streambed adjustments and scour

9. *Laboratory Investigation* [IN2, IN3, DE1, **DE2**, DE4]

Plan, design and interpret a laboratory investigation in support of a design project  
Instructor may expand on material presented in the course as appropriate

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

**General Learning Objectives:**

E=Evaluate, T=Teach, I=Introduce, (D) = Developing, (A) = Advanced level

Problem Analysis	E (A)	Teamwork	I	Ethics and Equity	
Investigation	E (A)	Communication	I	Economics and Project Management	
Design	E (A)	Professionalism		Life-Long Learning	
Engineering Tools	T	Impact on Society	T	Knowledge base	T

**Evaluation:**

The final mark will be determined as follows:

Participation	10 %
Assignments	15 %
Laboratory Project	15 %
Midterm	15 %
Final Examination	<u>45 %</u>
Total	100 %

**Note:** Participation will be tracked through forum posts and discussions during lecture hours.

### **1. Quizzes and Examinations:**

A 90-minute midterm exam will be held during tutorial hours. A three-hour final examination will take place during the examination period. Programmable calculators are not permitted in the final exam and tests. Both tests and the final examination will be Closed Book. A list of acceptable calculators for closed book exams will be posted on the bulletin board across from the Department of Civil and Environmental Engineering Office: please be sure your calculator is on it!

### **2. Weekly Assignments:**

Assignments will be given on a weekly basis. Assignments are to be submitted prior to the due date to OWL. Late assignments will be assessed a penalty of 10% per day, to a maximum of 4 days, after which they will receive a mark of zero. Extensions are to be negotiated with the course instructor, not the teaching assistants.

### **3. Laboratories:**

Students in small groups will plan, design and carry out a laboratory investigation of an environmental hydraulics problem. At the end of the course each group is required to submit a final report (~3000 words) and make a 10-min oral presentation. An additional progress report (1000 words) must also be submitted by each group for review and marking. A Logbook of group activities related to the project must be maintained and submitted as an attachment to the progress and final reports. Contributions by individual members of a group must be clearly identified in the Logbook and in the progress and final reports.

### **4. Use of English:**

In accordance with Senate and Faculty Policy, students may be penalized up to 10% of the marks on all assignments, tests, and examinations for improper use of English. Additionally poorly written work with the exception of the final examination may be returned without grading. If resubmission of the work is permitted, it may be graded with marks deducted for poor English and/or late submission.

### **CEE Course Outline Additional Information**

The sections below can be included following the “Evaluation” section of the sample course outline (replacing the red text in the course outline template). Text in blue below should appear in all course outlines. Text in red will be applicable to some courses and not to others.

### **Cheating:**

University policy states that cheating is a scholastic offence. The commission of a scholastic offence is attended by academic penalties that might include expulsion from the program. If you are caught cheating, there will be no second warning.

For more information on scholastic offenses, please see:

[http://www.uwo.ca/univsec/handbook/appeals/scholastic\\_discipline\\_undergrad.pdf](http://www.uwo.ca/univsec/handbook/appeals/scholastic_discipline_undergrad.pdf)

### **Attendance:**

Any student who, in the opinion of the instructor, has not engaged sufficiently in class, laboratory, or tutorial periods will be reported to the Dean (after due warning has been given). On the recommendation of the Department concerned, and with the permission of the Dean, the student will be debarred from taking the regular final examination in the course.

### **Accommodation:**

Students with disabilities work with Accessible Education (formerly SSD) which provides recommendations for accommodation based on medical documentation or psychological and cognitive testing. The accommodation policy can be found here: [Academic Accommodation for Students with Disabilities](#).

### **Academic Consideration for Student Absence**

Students will have up to two (2) opportunities during the regular academic year to use an on-line portal to self-report an absence during the term, provided the following conditions are met: the absence is no more than 48 hours in duration, and the assessment for which consideration is being sought is worth 30% or less of the student's final grade. Students are expected to contact their instructors within 24 hours of the end of the period of the self-reported absence, unless noted on the syllabus. Students are not able to use the self-reporting option in the following circumstances:

- for exams scheduled by the Office of the Registrar (e.g., December and April exams)
- absence of a duration greater than 48 hours,
- assessments worth more than 30% of the student's final grade,
- if a student has already used the self-reporting portal twice during the academic year

If the conditions for a Self-Reported Absence are *not* met, students will need to provide a Student Medical Certificate if the absence is medical, or provide appropriate documentation if there are compassionate grounds for the absence in question. Students are encouraged to contact their Faculty academic counselling office to obtain more information about the relevant documentation.

Students should also note that individual instructors are not permitted to receive documentation directly from a student, whether in support of an application for consideration on medical grounds, or for other reasons. **All documentation required for absences that are not covered**

**by the Self-Reported Absence Policy must be submitted to the Academic Counselling office of a student's Home Faculty.**

For Western University policy on Consideration for Student Absence, see

[Policy on Academic Consideration for Student Absences - Undergraduate Students in First Entry Programs](#)

and for the Student Medical Certificate (SMC), see:

[http://www.uwo.ca/univsec/pdf/academic\\_policies/appeals/medicalform.pdf](http://www.uwo.ca/univsec/pdf/academic_policies/appeals/medicalform.pdf).

### **Religious Accommodation**

Students should consult the University's list of recognized religious holidays, and should give reasonable notice in writing, prior to the holiday, to the Instructor and an Academic Counsellor if their course requirements will be affected by a religious observance. Additional information is given in the [Western Multicultural Calendar](#).

### **Conduct:**

Students are expected to arrive at lectures on time, and to conduct themselves during class in a professional and respectful manner that is not disruptive to others. Please turn off your cell phone before coming to a class, tutorial, quiz or exam. On the premises of the University or at a University-sponsored program, students must abide by the Student Code of Conduct:

<http://www.uwo.ca/univsec/board/code.pdf>

## **STATEMENT ON GENDER-BASED AND SEXUAL VIOLENCE**

Western [is committed to reducing incidents of gender-based and sexual violence](#) and providing compassionate support to anyone who has gone through these traumatic events. If you have experienced gender-based or sexual violence (either recently or in the past), you will find information about support services for survivors, including emergency contacts, [here](#). To connect with a case manager or set up an appointment, please contact [support@uwo.ca](mailto:support@uwo.ca).

## **INSTRUCTIONS FOR STUDENTS UNABLE TO WRITE TESTS OR EXAMINATIONS OR SUBMIT ASSIGNMENTS AS SCHEDULED**

If, on medical or compassionate grounds, you are unable to write term tests or final examinations or complete course work by the due date, you should follow the instructions listed below. You should understand that academic relief will not be granted automatically on request. You must demonstrate to your department (or the Undergraduate Services Office) that there are compelling medical or compassionate grounds that can be documented before academic relief will be considered. Different regulations apply to term tests, final examinations and late assignments. Please read the instructions carefully.

### **A. GENERAL REGULATIONS & PROCEDURES**

1. All first-year students will report to the Undergraduate Services Office by submitting the [Academic Consideration Request Form](#), for all instances.
2. If you are an upper year student and you are missing a test/assignment/lab or examination you will report the absence by submitting [Academic Consideration Request Form](#). Absences worth LESS THAN 10% of your mark, will be processed by your department office. If your course work is worth 10% OR MORE of your final grade, your request will be processed by the Undergraduate Services Office.
3. Check the course outline to see if the instructor has a policy for missed tests, examinations, late assignments or attendance.
4. Documentation must be provided as soon as possible. If no one is available in your department office or the Undergraduate Services Office, leave a message clearly stating your name & student number and reason for your call. The department telephone numbers are given at the end of these instructions.
5. If you decide to write a test or an examination you should be prepared to accept the mark you earn. Rewriting tests or examinations or having the value of a test or examination reweighted on a retroactive basis is not permitted.

### **B. TERM/MIDTERM TESTS**

1. If you are in first year and you are unable to write a midterm/term test, contact the Undergraduate Services Office, SEB 2097 PRIOR to the scheduled date of the test.
2. If you are an upper year student and you are unable to write a midterm/term test, inform your instructor PRIOR to the scheduled date of the test and request relief through the [Academic Consideration Request Form](#). If the instructor is not available, leave a message for him/her at the department office. If the test is worth LESS THAN 10% of your mark, your request for relief will be processed by your department office. If the test is worth MORE THAN 10% of your final grade your request for relief will be processed by the Undergraduate Services Office.
3. Be prepared to attach supporting documentation to the Department Chair and/or the Undergraduate Services Office through the online form (see next page for information on documentation).
4. Discuss with the instructor if and when the test can be rescheduled. The approval of the Chair or the Undergraduate Services Office is required when rescheduling midterm/term tests.

### C. **FINAL EXAMINATIONS**

1. If you are unable to write a final examination, contact the Undergraduate Services Office PRIOR TO THE SCHEDULED EXAMINATION TIME to report your absence using the [Academic Consideration Request Form](#) and request permission to write a Special Final Examination. If no one is available in the Undergraduate Services Office, leave a message clearly stating your name & student number.
2. Be prepared to provide the Undergraduate Services Office with supporting documentation (see next page for information on documentation) the next day, or as soon as possible (in cases where students are hospitalized). The following circumstances are not considered grounds for missing a final examination or requesting special examinations: common cold, headache, sleeping in, misreading timetable and travel arrangements.
3. In order to receive permission to write a Special Examination, you must obtain the approval of the Chair of the Department **and** the Associate Dean and in order to apply you must submit an "[Application for a Special Exam](#)" form. The Undergraduate Services Office will then notify the course instructor(s) and reschedule the examination on your behalf.

***PLEASE NOTE: It is the student's responsibility to check the date, time and location of the Special Examination.***

### D. **LATE ASSIGNMENTS**

1. Advise the instructor if you are having problems completing the assignment on time (**prior** to the due date of the assignment).



2. Be prepared to submit the [Academic Consideration Request Form](#) and provide documentation if requested by the instructor (see reverse side for information on documentation).
3. If you are granted an extension, establish a due date. The approval of the Chair of your Department (or the Assistant Dean, First Year Studies, if you are in first year) is not required if assignments will be completed prior to the last day of classes.
4. i) Extensions beyond the end of classes must have the consent of the instructor, the department Chair and the Associate Dean, Undergraduate Studies. Documentation is mandatory.
- ii) A Recommendation of Incomplete Form must be filled out indicating the work to be completed and the date by which it is due. This form must be signed by the student, the instructor, the department Chair and the Associate Dean, Undergraduate Studies.

#### E. **SHORT ABSENCES**

If you miss a class due to a minor illness or other problem, check your course outlines for information regarding attendance requirements and make sure you are not missing a test, laboratory or assignment. Cover any readings and arrange to borrow notes from a classmate.

#### F. **EXTENDED ABSENCES**

If you are absent more than one week or if you get too far behind to catch up, you should consider reducing your workload by dropping one or more courses. (Note drop deadlines listed below). You are strongly encouraged to seek advice from your Academic Counsellor in the Undergraduate Services Office.

#### G. **DOCUMENTATION**

If you consulted an off-campus doctor or Student Health Services regarding your illness or personal problem, **you must provide the doctor with a Student Medical Certificate** to complete at the time of your visit and then bring it to the Department (or the Undergraduate Services Office). **This note must contain the following information: severity of illness, effect on academic studies and duration of absence. Regular doctor's notes will not be accepted; only the Student Medical Certificate will be accepted.**

**In Case of Serious Illness of a Family Member:** Provide a Student Medical Certificate to your family member's physician to complete and bring it to the Department (or the Undergraduate Services Office if you are in first year).

**In Case of a Death:** Obtain a copy of the death certificate or the notice provided by the funeral director's office. You must include your relationship to the deceased and bring it to the Department (or the Undergraduate Services Office if you are in first year).

**For Other Extenuating Circumstances:** If you are not sure what documentation to provide, ask the Departmental Office (or the Undergraduate Services Office if you are in first year) for direction.

**Note: Forged notes and certificates will be dealt with severely. To submit a forged document is a scholastic offence (see below).**

## H. **ACADEMIC CONCERNS**

1. You need to know if your instructors have a policy on late penalties, missed tests, etc. This information may be included on the course outlines. If not, ask your instructor(s).
2. You should also be aware of attendance requirements in some courses. You can be debarred from writing the final examination if your attendance is not satisfactory.
3. If you are in academic difficulty, check out the minimum requirements for progression in the calendar. If in doubt, see your Academic Counsellor.

**Calendar References:** Check these regulations in your 2023 Western Academic Calendar available at [www.westerncalendar.uwo.ca](http://www.westerncalendar.uwo.ca).

### **Absences Due to Illness:**

[https://www.westerncalendar.uwo.ca/PolicyPages.cfm?Command=showCategory&PolicyCategoryId=1&SelectedCalendar=Live&ArchiveID=#Page\\_135](https://www.westerncalendar.uwo.ca/PolicyPages.cfm?Command=showCategory&PolicyCategoryId=1&SelectedCalendar=Live&ArchiveID=#Page_135)

### **Academic Accommodations for Students with Disabilities:**

[http://www.westerncalendar.uwo.ca/PolicyPages.cfm?Command=showCategory&PolicyCategoryId=1&SelectedCalendar=Live&ArchiveID=#Page\\_10](http://www.westerncalendar.uwo.ca/PolicyPages.cfm?Command=showCategory&PolicyCategoryId=1&SelectedCalendar=Live&ArchiveID=#Page_10)

### **Academic Accommodations for Religious or Holy Days:**

[http://www.westerncalendar.uwo.ca/PolicyPages.cfm?Command=showCategory&PolicyCategoryId=1&SelectedCalendar=Live&ArchiveID=#Page\\_16](http://www.westerncalendar.uwo.ca/PolicyPages.cfm?Command=showCategory&PolicyCategoryId=1&SelectedCalendar=Live&ArchiveID=#Page_16)

### **Course Withdrawals:**

[http://www.westerncalendar.uwo.ca/PolicyPages.cfm?Command=showCategory&PolicyCategoryId=6&SelectedCalendar=Live&ArchiveID=#Page\\_75](http://www.westerncalendar.uwo.ca/PolicyPages.cfm?Command=showCategory&PolicyCategoryId=6&SelectedCalendar=Live&ArchiveID=#Page_75)

### **Examinations:**

[http://www.westerncalendar.uwo.ca/PolicyPages.cfm?PolicyCategoryId=5&command=showCategory&SelectedCalendar=Live&ArchiveID=#Page\\_78](http://www.westerncalendar.uwo.ca/PolicyPages.cfm?PolicyCategoryId=5&command=showCategory&SelectedCalendar=Live&ArchiveID=#Page_78)

### **Scheduling of Term Assignments:**

[http://www.westerncalendar.uwo.ca/PolicyPages.cfm?Command=showCategory&PolicyCategoryId=5&SelectedCalendar=Live&ArchiveID=#SubHeading\\_78](http://www.westerncalendar.uwo.ca/PolicyPages.cfm?Command=showCategory&PolicyCategoryId=5&SelectedCalendar=Live&ArchiveID=#SubHeading_78)

### **Scholastic Offences:**

[http://www.westerncalendar.uwo.ca/PolicyPages.cfm?Command=showCategory&PolicyCategoryId=1&SelectedCalendar=Live&ArchiveID=#Page\\_20](http://www.westerncalendar.uwo.ca/PolicyPages.cfm?Command=showCategory&PolicyCategoryId=1&SelectedCalendar=Live&ArchiveID=#Page_20)

**Student Medical Certificate:**

<https://www.eng.uwo.ca/files/undergraduate/student-medical-certificate.pdf>

**Engineering Academic Regulations:**

[http://www.westerncalendar.uwo.ca/PolicyPages.cfm?Command=showCategory&PolicyCategoryID=4&SelectedCalendar=Live&ArchiveID=#Page\\_86](http://www.westerncalendar.uwo.ca/PolicyPages.cfm?Command=showCategory&PolicyCategoryID=4&SelectedCalendar=Live&ArchiveID=#Page_86)

**Note:** These instructions apply to all students registered in the Faculty of Engineering regardless of whether the courses are offered by the Faculty of Engineering or other faculties in the University.

**Add Deadlines:**

	First term half course (i.e. “A” or “F”)
September 15, 2023	
	Full courses and full-year half course (i.e. “E”, “Y” or no suffix)
September 15, 2023	
	Second term half course (i.e. “B” or “G”)
January 16, 2024	

**Drop Deadlines:**

	First term half course without penalty (i.e. “A” or “F”)
November 13, 2023	
	Full courses and full-year half courses without penalty (i.e. “E”, “Y” or no suffix)
November 30, 2023	
	Second term half or second term full course without penalty (i.e. “B” or “G”)
March 7, 2024	

**Contact Information:**

Undergraduate Services Office:	SEB 2097	Phone: 519-661-2130
E-mail: <a href="mailto:engugrad@uwo.ca">engugrad@uwo.ca</a>		
Chemical & Green Process Engineering:	TEB 477	Phone: 519-661-2131
E-mail: <a href="mailto:cbeugrad@uwo.ca">cbeugrad@uwo.ca</a>		
Civil Engineering:	SEB 3005	Phone: 519-661-2139
E-mail: <a href="mailto:civil@uwo.ca">civil@uwo.ca</a>		
Computer, Electrical, Mechatronic Systems & Software Engineering	TEB 279	Phone: 519-661-3758
E-mail: <a href="mailto:eceugrad@uwo.ca">eceugrad@uwo.ca</a>		
Integrated Engineering	ACEB 2410	Phone: 519-661-6725
E-mail: <a href="mailto:engceli@uwo.ca">engceli@uwo.ca</a>		
Mechanical Engineering:	SEB 3002	Phone: 519-661-4122
E-mail: <a href="mailto:mmeundergraduate@uwo.ca">mmeundergraduate@uwo.ca</a>		