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/week;
Lectures will be delivered synchronously through Zoom each week during the scheduled hours. All lectures will be recorded and posted to the course OWL site. Lectures will be organized into learning modules which students should review on a weekly basis. Review of lecture material and self-study should take approximately 5 hours per week.

2 tutorial hours/week.
A 2-hour tutorial session will be delivered synchronously through Zoom each week during the scheduled tutorial hours. Tutorials are not mandatory but students seeking assistance with weekly assignments or clarification on lecture material are strongly encouraged to attend. The link to the Zoom meeting will be posted to OWL.

**Note:** Reliable internet connection is a requirement for ALL students participating in this class.

**Instructor:**
Dr. Mohammad Reza Najafi, CMLP 1301
mnajafi7@uwo.ca
Office hours: Tuesdays 9:30-10:30 via Zoom (link can be found on course OWL site)

Administrative Assistant: Sandra McKay (smckay@uwo.ca)

**Textbook:**
The required text for this class is:

**Other References**

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

**Specific Learning Objectives:**
1. **Basic Principles**
   - 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**
   - 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**
• 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
• 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
• 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
• Design spillways to transfer large flood discharges safely downstream from a reservoir
• Describe and apply methods for computing bridge backwater effects

7. Unsteady Flow
• Describe the development and application of dynamic wave equations
• Apply the Saint-Venant equations to characterize unsteady flow conditions

8. Flow in Alluvial Channels
• 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.
Plan, design and conduct 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

<table>
<thead>
<tr>
<th>Problem Analysis</th>
<th>E (A)</th>
<th>Team Work</th>
<th>I</th>
<th>Ethics and Equity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Investigation</td>
<td>E (A)</td>
<td>Communication</td>
<td>I</td>
<td>Economics and Project Management</td>
</tr>
<tr>
<td>Design</td>
<td>E (A)</td>
<td>Professionalism</td>
<td></td>
<td>Life-Long Learning</td>
</tr>
<tr>
<td>Engineering Tools</td>
<td>E (A)</td>
<td>Impact on Society</td>
<td>T</td>
<td>Knowledge base</td>
</tr>
<tr>
<td>-------------------</td>
<td>------</td>
<td>-------------------</td>
<td>---</td>
<td>----------------</td>
</tr>
</tbody>
</table>

**Evaluation:**
The final mark will be determined as follows:

- Participation: 10%
- Assignments: 20%
- Laboratory Project: 15%
- Midterm: 15%
- Written Final Examination: 30%
- Oral Final Examination: 10%
- 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. The exam will be conducted online by using randomized questions via the OWL platform.

   A three-hour written final examination will be held during the regular examination period. 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.

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:**
   Labs will likely be presented through pre-recorded video. Students in small groups will plan, design and interpret the results of 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.

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

**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 online 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:

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.

Use of Recordings:

All of the remote learning sessions for this course will be recorded. The data captured during these recordings may include your image, voice recordings, chat logs and personal identifiers (name displayed on the screen). The recordings will be used for educational purposes related to this course, including evaluations. The recordings may be disclosed to other individuals under special circumstances. Please contact the instructor if you have any concerns related to session recordings.

Participants in this course are not permitted to record the sessions, except where recording is an approved accommodation, or the participant has the prior written permission of the instructor.

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

Use the above for 4th year in-person courses
Use the below for online courses
Some components of this course will involve online interactions. To ensure the best experience for both you and your classmates, please honour the following rules of etiquette:

- please “arrive” to class on time
- please use your computer and/or laptop if possible (as opposed to a cell phone or tablet)
- ensure that you are in a private location to protect the confidentiality of discussions in the event that a class discussion deals with sensitive or personal material
- to minimize background noise, kindly mute your microphone for the entire class until you are invited to speak, unless directed otherwise
- [suggested for classes larger than 30 students] In order to give us optimum bandwidth and web quality, please turn off your video camera for the entire class unless you are invited to speak
- [suggested for cases where video is used] please be prepared to turn your video camera off at the instructor’s request if the internet connection becomes unstable
- unless invited by your instructor, do not share your screen in the meeting

The course instructor will act as moderator for the class and will deal with any questions from participants. To participate please consider the following:

- if you wish to speak, use the “raise hand” function and wait for the instructor to acknowledge you before beginning your comment or question
- remember to unmute your microphone and turn on your video camera before speaking
- self-identify when speaking.
- remember to mute your mic and turn off your video camera after speaking (unless directed otherwise)

General considerations of “netiquette”:

- Keep in mind the different cultural and linguistic backgrounds of the students in the course.
- Be courteous toward the instructor, your colleagues, and authors whose work you are discussing.
- Be respectful of the diversity of viewpoints that you will encounter in the class and in your readings. The exchange of diverse ideas and opinions is part of the scholarly environment. “Flaming” is never appropriate.
- Be professional and scholarly in all online postings. Cite the ideas of others appropriately.

Note that disruptive behaviour of any type during online classes, including inappropriate use of the chat function, is unacceptable. Students found guilty of Zoom-bombing a class or of other serious online offenses may be subject to disciplinary measures under the Code of Student Conduct.

**Contingency plan for an in-person class pivoting to 100% online learning:**

In the event of a COVID-19 resurgence during the course that necessitates the course delivery moving away from face-to-face interaction, all remaining course content will be delivered entirely online, either synchronously (i.e., at the times indicated in the timetable) or asynchronously (e.g., posted on OWL for students to view at their convenience). The grading
scheme will not change. Any remaining assessments will also be conducted online as determined by the course instructor.

**Online Proctoring Notice:**

1. If using Proctortrack or alternative remote proctoring solution only:

Tests and examinations in this course will be conducted using the remote proctoring service, Proctortrack. By taking this course, you are consenting to the use of this software and acknowledge that you will be required to provide personal information (including some biometric data) and the session will be recorded. More information about this remote proctoring service is available in the Online Proctoring Guidelines at the following link:


Completion of this course will require you to have a reliable internet connection and a device that meets the technical requirements for this service. Information about the technical requirements are available at the following link:

https://www.proctortrack.com/tech-requirements/.

2. If using Zoom Only:

Tests and examinations in this course will be conducted using Zoom. You will be required to keep your camera on for the entire session, hold up your student card for identification purposes, and share your screen with the invigilator if asked to do so at any time during the exam. The exam session will not be recorded.*

More information about the use of Zoom for exam invigilation is available in the Online Proctoring Guidelines at the following link:


Completion of this course will require you to have a reliable internet connection and a device that meets the system requirements for Zoom. Information about the system requirements are available at the following link:

https://support.zoom.us/hc/en-us.

* Please note that Zoom servers are located outside Canada. If you would prefer to use only your first name or a nickname to login to Zoom, please discuss this with your instructor in advance of the test or examination.

3. If using both Zoom and Proctortrack or alternative remote proctoring solution:
Tests and examinations in this course will be conducted using both Zoom and the remote proctoring service, Proctortrack.

When Zoom is used for exam invigilation, you will be required to keep your camera on for the entire session, hold up your student card for identification purposes, and share your screen with the invigilator if asked to do so at any time during the exam. The exam session using Zoom will not be recorded.*

Proctortrack will require you to provide personal information (including some biometric data). The session will be recorded. By taking this course, you are consenting to the use of this software. More information about remote proctoring is available in the Online Proctoring Guidelines at the following link:


Completion of this course will require you to have a reliable internet connection and a device that meets the system and technical requirements for both Zoom and Proctortrack. Information about the system and technical requirements are available at the following links:

https://www.proctortrack.com/tech-requirements/,
https://support.zoom.us/hc/en-us.

* Please note that Zoom servers are located outside Canada. If you would prefer to use only your first name or a nickname to login to Zoom, please discuss this with your instructor in advance of the test or examination.

**Notice:**

Students are responsible for regularly checking their email, course website (https://owl.uwo.ca) and notices posted outside the Civil and Environmental Engineering Department Office

**Consultation:**

Students are encouraged to discuss problems with their teaching assistant and/or the Instructor in tutorial sessions. Office hours will be arranged for the students to meet with the Instructor and teaching assistants. Other individual consultation can be arranged by appointment with the instructor.

The document “INSTRUCTIONS FOR STUDENTS UNABLE TO WRITE TESTS OR EXAMINATIONS OR SUBMIT ASSIGNMENTS AS SCHEDULED” is part of this course outline.