This course introduces the basic fundamentals of fluid mechanics, and how they are applied to topics that are likely to be of interest to civil engineers. The general objectives of the course are for students to become able to:

- identify, formulate and solve basic fluid mechanics problems related to fluid statics, buoyancy, dimensional analysis, pipe networks, open channels and boundary layers while working individually or functioning on a team; and to
- conduct experiments, analyze and interpret data, rationally account for differences between predicted and observed behaviours, and communicate the findings effectively in concise and complete laboratory reports.

**Calendar Copy:**
Basic concepts of fluid mechanics: fluid statics; continuity, momentum and energy equations; vortex flow; flow of real fluids and boundary layers; dimensional analysis. These principles are applied to pipe and open channel flows: steady pipe flows, uniform and gradually-varied flow in open channels; sluice gates, weirs and hydraulic jumps, unsteady flows. (1.0 course)

**Prerequisites:**
ES1022A/B/y, Physics 1401A/B (or the former Physics 1026)

**Corequisites:**
NMM 2270A/B (or the former AM 2270A/B)

**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:**
3 lecture hours per week, 2 tutorial hours per week, 3 lab hours 4 times per year.

Additional self-study: 4 hours/week.

Attendance at the tutorial/laboratory sessions is **mandatory**
Key Sessional Dates:

- Classes begin: September 8, 2022; January 9, 2023
- Fall Reading Week: October 31 – November 6, 2022; Winter Reading Week: February 18 – 26, 2023
- Classes end: December 8, 2022; April 10, 2023
- Exam period: December 10 – 22, 2022; April 13 – 30, 2023

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, affected 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.

Instructors:

Fall term:
- Dr. Craig Miller, P.Eng.; SEB 2084; e-mail: cmiller@eng.uwo.ca
- Office hours: by appointment

Winter term:
- Dr. Sabina Rakhimbekova; SEB 3041, e-mail: srakhimbe@uwo.ca
- Office hours: TBD

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

Textbook:


Other References:

- There are many fluid mechanics texts available, which cover largely the same material.
- Students are responsible for checking the course OWL site ([http://owl.uwo.ca](http://owl.uwo.ca)) on a regular basis for news and updates. This is the primary method by which information will be disseminated to all students in the class.

All course material will be posted to OWL: [http://owl.uwo.ca](http://owl.uwo.ca).

If students need assistance with the course OWL site, they can seek support on the OWL Help page. Alternatively, they can contact the Western Technology Services Helpdesk. They can be contacted by phone at 519-661-3800 or ext. 83800.

Units:

- Both SI and FPS unit systems may be used in lectures, tutorials and examinations.
By the end of each term, the student will be able to:

**Fall Term:**

1) **Fluid Properties** [KB2, KB3]
   a) describe units in both SI and US Customary systems
   b) define mass, weight and volume
   c) describe elasticity and compressibility as applied to a fluid
   d) define absolute, gauge and differential pressure
   e) describe vapour pressure, cavitation and viscosity

2) **Fluid Statics** [KB2, KB3]
   a) calculate pressure at a point applying Pascal’s Law
   b) calculate pressure in compressible and incompressible static fluids
   c) describe the effects of compressibility on specific weight and pressure
   d) calculate the forces on vertical, inclined and curved submerged surfaces
   e) calculate pressures in constantly accelerated fluids

3) **Buoyancy and Stability** [KB2, KB3, I1, I2, I3]
   a) apply Archimedes Principle
   b) define and calculate buoyancy and stability of bodies in/on fluids

4) **Dimensional Analysis** [KB2, KB3]
   a) apply dimensional analysis techniques
   b) define dynamic similarity

5) **Introduction to Fluid Flow** [KB2, KB3, I1, I2, I3]
   a) describe the properties and types of fluid flows
   b) apply the principles of flow analysis to steady incompressible flows
   c) apply the ideal steady flow equations (continuity, momentum and energy)
   d) describe how ideal steady flow assumptions relate to real fluid flows

**Winter Term:**

1) **Pipe Networks** [KB4]
   a) manipulate the solution for the flow rate and velocity distribution between two flat plates (i.e., Hagen-Poiseuille flow) for different boundary conditions and applications
   b) identify and apply assumptions and boundary conditions in conjunction with the energy (Bernoulli), continuity, and momentum equations to solve pipe flow problems
   c) identify and calculate frictional losses using the Darcy-Weisbach equation and the Moody diagram
   d) identify and calculate separation (minor) losses
   e) calculate flow rates and losses in “simple pipes”, pipes in series and parallel, in branching pipe networks and in three reservoir problems
   f) use the Hardy-Cross method for solving pipe network problems

2) **Boundary Layers and External Flows** [KB4, I1, I2, I3]
   a) describe the velocity profiles in laminar and turbulent boundary layers
   b) estimate friction drag
   c) estimate pressure drag for various external flows

3) **Open Channel Flows** [KB4, I1, I2, I3]
   a) identify assumptions and boundary conditions necessary to solve open channel problems
   b) apply the energy (Bernoulli), continuity, and momentum equations to open channel problems in uniform flow, gradually varied flow and rapidly varied flow
   c) calculate the optimum shape of cross-section for uniform open channel flow
   d) apply the Manning equation for flow resistance
   e) recognize and calculate critical flow conditions
f) understand the use of, and make calculations related to, various flow control devices such as sluice gates and weirs


g) sketch and calculate water surface profiles in gradually varied open channel flows


h) predict the existence of hydraulic jumps and other rapidly varying flow conditions


i) calculate gradually varied flows with the standard-step method

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

**General Learning Objectives:**

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

**Evaluation:**

The final mark will be determined as follows:

- MasteringEngineering tutorial assignments: 15%
- Tutorial quizzes: 15%
- Laboratories: 10%
- Midterm (December) exam: 30%
- Final exam: 30%
- Total: 100%

**Note:** Students must pass the aggregate of the midterm and final examinations to pass this course. Students who fail the final examination will be assigned the aggregate mark, as determined above, or 48%, whichever is less. 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.

1. **Quizzes and Examinations:**

   Weekly tutorial quizzes will take place during the scheduled tutorial period, during both the Fall and Winter terms.

   Three-hour written midterm and final exams will be held during the regular December and April examination periods respectively.

   Except for the use of a calculator, all quizzes and the midterm and final examinations are closed book. Only approved programmable calculators are permitted in the midterm and final examinations and quizzes. Students should consult the list of approved calculators posted outside the Civil and Environmental Engineering Department Office. Formula sheets and other required reference material will be provided as part of the quiz, midterm and final examination papers.
2. **Weekly Assignments:**
Weekly assignments will be given using MasteringEngineering. Assignments are to be submitted prior to the due date on MasteringEngineering. To receive full marks for a question, all parts of the question must be completed. Questions with uncompleted parts will receive a mark of zero for the entire question, irrespective of how many parts have been completed before the due date. Extensions are to be negotiated with the course instructor, not the teaching assistants.

3. **Laboratories:**
Students in small groups will perform three or four laboratory experiments, with a maximum of two per term. Group reports are due one week after the end of the laboratory period in which the experiment is performed, unless otherwise directed, with a copy of the report to be submitted electronically for grading. Reports that are found to be plagiarized will be given a mark of zero. Without special permission late reports will not be marked. Late submissions will be penalized.

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.

**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, is absent too frequently from 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 and Accessibility:**

**Religious Accommodation**
When a course requirement conflicts with a religious holiday that requires an absence from the University or prohibits certain activities, students should request accommodation for their absence in writing at least two weeks prior to the holiday to the course instructor and/or the Academic Counselling office of their Faculty of Registration. Please consult University's list of recognized religious holidays (updated annually) at


**Accommodation Policies**
Students with disabilities are encouraged to contact Accessible Education, which provides recommendations for accommodation based on medical documentation or psychological and cognitive testing. The policy on Academic Accommodation for Students with Disabilities can be found at:

https://www.uwo.ca/univsec/pdf/academic_policies/appeals/Academic_Accommodation_disabilities.pdf.
**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

**Sickness and Other Problems:**
If you are unable to meet a course requirement due to illness or other serious circumstances, please follow the procedures below.

**Assessments worth less than 10% of the overall course grade:**
Assessments will not be provided for missed weekly tutorial quizzes, instead the lowest two quiz marks in each term will be dropped when calculating the contribution of the quizzes to the final grade for the course. Extensions will be given for the weekly MasteringEngineering assignments.

**Assessments worth 10% or more of the overall course grade:**
For work totalling 10% or more of the final course grade, you must provide valid medical or supporting documentation to the Academic Counselling Office of your Faculty of Registration as soon as possible. For further information, please consult the University’s medical illness policy at
The Student Medical Certificate is available at

**Absences from Midterm and Final Examinations**
If you miss the Midterm or Final Exam, please contact Western Engineering Undergraduate Services as soon as possible. They will assess your eligibility to write the Special Examination.

You may also be eligible to write the Special Exam if you are in a “Multiple Exam Situation” (e.g., more than 2 exams in 23-hour period, more than 3 exams in a 47-hour period).

If a student fails to write a scheduled Special Examination, the date of the next Special Examination (if granted) normally will be the scheduled date for the final exam the next time this course is offered. The maximum course load for that term will be reduced by the credit of the course(s) for which the final examination has been deferred. See the Academic Calendar for details (under Special Examinations).

**Note:** missed work can only be excused through one of the mechanisms above. Being asked not to attend an in-person course requirement due to potential COVID-19 symptoms is not sufficient on its own.
Academic Policies:
The website for Registrarial Services is http://www.registrar.uwo.ca.

In accordance with policy,

https://www.uwo.ca/univsec/pdf/policies_procedures/section1/mapp113.pdf,

the centrally administered e-mail account provided to students will be considered the individual’s official university e-mail address. It is the responsibility of the account holder to ensure that e-mail received from the University at their official university address is attended to in a timely manner.

Scholastic offences are taken seriously, and students are directed to read the appropriate policy, specifically, the definition of what constitutes a Scholastic Offence, at the following Web site:


Support Services:
Please visit the Western Engineering Undergraduate Services webpage for information on adding/dropping courses, academic considerations for absences, appeals, exam conflicts, and many other academic related matters: https://www.eng.uwo.ca/undergraduate/index.html

Students who are in emotional/mental distress should refer to Mental Health@Western (https://uwo.ca/health/) for a complete list of options about how to obtain help.

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 sexual or gender-based violence (either recently or in the past), you will find information about support services for survivors, including emergency contacts at


To connect with a case manager or set up an appointment, please contact support@uwo.ca.

Please contact the course instructor if you require lecture or printed 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

http://academicsupport.uwo.ca/accessible_education/index.html

if you have any questions regarding accommodations.

Learning-skills counsellors at the Student Development Centre (https://learning.uwo.ca) are ready to help you improve your learning skills. They offer presentations on strategies for improving time management, multiple-choice exam preparation/writing, textbook reading, and more. Individual support is offered throughout the Fall/Winter terms in the drop-in Learning Help Centre, and year-round through individual counselling.

Western University is committed to a thriving campus as we deliver our courses in the mixed model of both virtual and face-to-face formats. We encourage you to check out the Digital Student Experience website to manage your academics and well-being: https://www.uwo.ca/se/digital/.

Additional student-run support services are offered by the USC, https://westernusc.ca/services/.
**Course Breakdown:** (Values given in accreditation units)
30% Natural Science; 70% Engineering Science.

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

Academic Consideration provides students with consistent, fair, and academically appropriate consideration, when they are unable to complete some component of a course due to extenuating circumstances. If you have missed or will miss a course-related component (e.g. laboratory or tutorial) or a course-related assessment (e.g. quiz) you may be eligible to request an Academic Consideration to make arrangements to complete the missed course work at a later time.

Academic Consideration for course-related components and assessments may include:
- Class Attendance/Tutorial Attendance/Laboratory Attendance
- Midterm Exam/Test
- Presentation/Essay/Assignment
- Quiz

There are three ways you can request academic consideration:
- Self-Reported Absence
- Medical Absence
- Non-Medical Absence

The nature of your circumstance/request will determine which route to pursue in requesting Academic Consideration. Factors affecting your eligibility for consideration or which method would be most appropriate for you to submit your request are:
- The duration of time needed.
- The number of Self-Reported Absences submitted within the Term
- The credit weight of the course-related component

Tip: Remember to send notification of your absence within the acceptable timeframe for your type of absence. Make sure to communicate with your instructor about your absence and to plan for completing any missed coursework.

Medical Absence and Non-Medical Absence – Use the Accommodation Consideration Request Form. Please note: If the assessment you are missing is less than 10% of your final grade, your form will be approved by the CEE department; if it worth 10% or more, your form will be approved by Engineering Undergraduate Services.

- Student Medical Certificate to be attached to Accommodate Request Form if absence is due to illness.
- Extended Absences – two weeks or more. Please make an appointment with your Academic Counsellor in Engineering Undergraduate Services (https://www.eng.uwo.ca/undergraduate/academic-support-and-accommodations/academic-counselling.html)
- In Case of Serious Illness of a Family Member: Provide a Student Medical Certificate to your family member's physician to complete and submit it with your Accommodation Consideration Request.
- 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 submit it with your
Accommodation Consideration Request

- For other Extenuating Circumstances: Please complete the Accommodation Consideration Request Form with an explanation and any documentation.

Final Examinations

If you are unable to write a final examination, you should contact Undergraduate Services to request permission to write a Special Examination.

In order to receive permission to write a Special Examination, you must fill out the Academic Consideration Request form AND the Application for a Special Exam form. If approved, the Undergraduate Services Office will then notify the course instructor(s) and if it is an Engineering exam(s) you missed, reschedule the examination(s) on your behalf. Students writing examinations for outside engineering courses (ie. Applied Math, Computer Science, Physics, etc) will need to check with that department to find out the date, time & location of their exam(s).

Please note: It is the student's responsibility to check the date, time, and location of the special examination.

You will need to provide supporting documentation explaining the reason for your absence. If you are ill and visit a doctor, they will need to fill out the Student Medical Certificate. You will upload this documentation in the Academic Consideration Request Form. The following circumstances are not considered grounds for missing a final examination or requesting special examinations: common cold, sleeping in, misreading timetable and travel arrangements.

Additional Resources

- To connect with health and wellness resources on campus visit: https://www.uwo.ca/health/
- To book an appointment with psychological services visit: https://www.uwo.ca/health/psych/index.html

Calendar References: Check these regulations in your Western Academic Calendar available at www.westerncalendar.uwo.ca.

Self-Reporting Absences
Absences Due to Illness
Academic Accommodations for Students with Disabilities
Academic Accommodations for Religious or Holy Days
Course Withdrawals
Examinations
Scheduling of Term Assignments
Scholastic Offences
Student Medical Certificate
Engineering Academic Regulations

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.

Contact Information: