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:**

Applied Mathematics 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:**

Lectures will be delivered asynchronously through pre-recorded videos 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 6 hours per week.

1 small group tutorial hour/week.
Small group tutorials will take place online each week during the hours that lectures would be normally scheduled. Each student will attend one 1-hour small group tutorial each week, as per the schedule to be posted to the course OWL site at the start of the academic year in September. This schedule will remain fixed for the duration of the course.

2 class tutorial hours/week
The second hour of the scheduled 2-hour tutorial session on a Monday afternoon will be used to deliver a weekly online quiz using MasteringEngineering to ensure students are working their way through the learning modules as posted to OWL. The hour of this tutorial session will be run as an additional online tutorial for those students seeking additional assistance with small group tutorial assignments or clarification of lecture material.

All online small group and class tutorials will be delivered synchronously through Blackboard Collaborate UE accessed via OWL.

**Instructor:**

CEE 2224 – Engineering Fluid Mechanics – Course Outline 2020-21
Textbook:


Other References:
There are many fluid mechanics texts available which cover largely the same material.

Computing:
Assignments may involve numerical calculations that require the use of a computer. The students may use any computer and programming environment of their choice to perform these calculations, unless otherwise directed.

Specific Learning Objectives:
By the end of each term, the student will be able to:

**Fall Term:**
1) Fluid Properties [KB1, 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 [KB1, 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 [KB1, KB2, KB3]
   a) apply Archimedes Principle
   b) define and calculate buoyancy and stability of bodies in/on fluids
4) Dimensional Analysis [KB1, KB2, KB3]
   a) apply dimensional analysis techniques
   b) define dynamic similarity
5) Introduction to Fluid Flow [KB1, KB2, KB3]
   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]
   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]
   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:**

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<th>Knowledge Base</th>
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<th>Engineering Tools</th>
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<td>Problem Analysis</td>
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<td>Team Work</td>
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<td>Investigation</td>
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<td>Design</td>
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<td>Professionalism</td>
<td>Life-Long Learning</td>
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**Evaluation:**

The final course mark will be determined as follows:

- MasteringEngineering small group tutorial assignments: 20%
- MasteringEngineering tutorial quizzes: 20%
- Laboratories: 10%
- Midterm (December) exam: 25%
- Final assessment: 25%

Total: 100%

1. **Quizzes and Examinations:**

Online tutorial quizzes delivered using MasteringEngineering will take place during the second hour of the Monday afternoon tutorial as scheduled during both the Fall and Winter terms.

Three-hour written mid-year and final assessments will be held during the regular December 2020 and April 2021 examination periods respectively. These will be delivered through OWL or Gradescope, and will require the submission of written answers to the delivered questions.

2. **Weekly Assignments:**
Small group tutorial assignments will be given on a weekly basis 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 undertake four laboratory experiments online, two per term, according to the laboratory schedule posted on OWL. Laboratories will be presented through pre-recorded video accessed on OWL, along with data measurements for analysis. Electronic group laboratory reports are due one week after the laboratory period in which the experiment is performed, unless otherwise directed. 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.

Use of Recordings:

Remote learning sessions for this course may 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.

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.

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. 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

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
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
- 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
- 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.

**Academic Consideration for Student Absences:**

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

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.

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 see the Instructor and teaching assistants. Other individual consultation can be arranged by appointment with the instructor.

Course Breakdown:
30% Natural Science; 70% Engineering Science.

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