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:**
Numerical and Mathematical Methods 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/week; 2 tutorial hours; 1 laboratory hour; (recommended additional personal study - 4 hrs).

Attendance at the tutorial/laboratory sessions is mandatory

**Instructor:**
Dr. Craig Miller, P.Eng.; SEB 2084; e-mail: cmiller@eng.uwo.ca. Administrative Support: SEB 3005

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

Laboratories:
Students in small groups will perform four laboratory experiments. Group reports are due one week after the end of the laboratory period in which the experiment is performed, unless otherwise directed, with an 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.

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, I1, I2, I3]
   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, 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:

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<tr>
<th>Knowledge Base</th>
<th>E (D)</th>
<th>Engineering Tools</th>
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<td>Problem Analysis</td>
<td>T (D)</td>
<td>Team Work</td>
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<tr>
<td>Investigation</td>
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<td>Design</td>
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Evaluation:
The final course mark will be determined as follows:

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

Total: 100%
Note: (a) Students must turn in all laboratory reports, and achieve a passing grade in the laboratory component, 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 http://www.uwo.ca/univsec/handbook/appeals/accommodation_religious.pdf

1. Quizzes and Examinations:
Tutorial quizzes will take place during the second hour of the tutorial, as scheduled, during both the Fall and Winter terms. Quizzes will be CLOSED BOOK: no programmable calculators or other external sources of information, including books, notes or crib sheets, are permitted. 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! Midterm (December) and Final Exams will be CLOSED BOOK. Part marks may not be awarded for some of the problems on the quizzes or final exam.

2. Tutorial Assignments:
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. Use of English
In accordance with Senate and Faculty Policy, students may be penalised up to 10% of the marks on all assignments, tests, and examinations for the 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: https://www.uwo.ca/univsec/pdf/academic_policies/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: https://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.

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.

Notice:
Students are responsible for regularly checking their email, course website (https://owl.uwo.ca/portal) 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.

Course Breakdown:
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.