Conservation of mass and linear momentum, differential analysis of the flow, centrifugal pumps, dimensional analysis, laminar and turbulent boundary layers, drag and lift forces on objects, description of turbulence

**Instructor:** Kamran Siddiqui  
Room SEB 2078  
E-mail: ksiddiq@uwo.ca

**Lectures:**  
T, 12:30-1:30 (Online, Zoom)  
W, 11:30-12:30 (Online, Zoom)  
Th, 8:30-9:30 (Online, Zoom)

**Tutorials:**  
Th, 9:30-11:30 (Online, Zoom)

**Labs:**  
003 – T, 9:30-12:30 (Online, Zoom)  
004 – M, 8:30-11:30 (Online, Zoom)  
005 – Th, 1:30-4:30 (Online, Zoom)  
006 – M, 2:30-5:30 (Online, Zoom)  
007 – W, 8:30-11:30 (Online, Zoom)

**PREREQUISITES:** MME 2273A/B

**COREQUISITES:** Applied Mathematics 3413A/B

Unless you have either the requisites for this course or written special permission from your Dean to enroll in it, you will be removed from this course and it will be deleted from your record. This decision may not be appealed. You will receive no adjustment to your fees in the event that you are dropped from a course for failing to have the necessary prerequisites.

**ACCREDITATION UNITS:**  
Engineering Science = 100%

**TOPICS:**

1. Fundamental concepts
2. Differential relations for fluid flow  
   - Conservation of mass  
   - Conservation of momentum  
   - Navier-Stokes equations
3. Dimensional analysis  
   - Dimensionless parameters  
   - Buckingham Pi theorem  
   - Relationship between model and full-scale flows
4. Flow past immersed bodies  
   - Boundary layer flows  
   - Drag and lift on immersed bodies
5. Turbomachinery  
   - Pumps  
   - Pump performance curves  
   - System characteristics and pump selection
6. Introduction to turbulence  
   - Reynolds decomposition  
   - Physical nature of turbulent flows
LEARNING OUTCOMES
Students successfully completing this course will be able to,
1. Relate fluid mechanics fundamentals to a wide range of real world engineering applications
2. Develop non-dimensional parameters for generalized parametric analysis
3. Predict the performance of a full-scale prototype based on model testing
4. Compute drag and lift forces on a wide range of objects
5. Interpret pump characteristic curves and evaluate pump’s performance
6. Describe the fundamental characteristics of turbulent flows

CONTACT HOURS:
3 lecture hours and 2 tutorial hour per week, 0.5 laboratory hours per week, half course

TEXT:
Fluid Mechanics, Frank White, Seventh or Eighth edition, McGraw Hill.

REFERENCES:

UNITS:
Both SI and Imperial units.

EVALUATION:
The final course grade will be determined according to the following weighting scheme:

In-class participation (iClicker assessment): 20%
Weekly in-tutorial assignments: 15%
Laboratory data analysis and report: 15%
Term test 1 (closed book, Proctortrack): 10%
Term test 2 (closed book, Proctortrack): 10%
Final exam (closed book, Proctortrack): 30%

Tests, tutorial assignments, class participation and laboratories will be carried out according to the following tentative schedule:

<table>
<thead>
<tr>
<th>Evaluation Format</th>
<th>Weight</th>
<th>Effort Type</th>
<th>Assigned</th>
<th>Due</th>
</tr>
</thead>
<tbody>
<tr>
<td>Class participation</td>
<td>20%</td>
<td>Individual</td>
<td>Weekly</td>
<td>End of assigned lecture hour</td>
</tr>
<tr>
<td>In-tutorial assignments</td>
<td>15%</td>
<td>Team</td>
<td>Weekly except Sep. 10, Sep. 17 and Nov. 12</td>
<td>End of tutorial hour in which it is assigned</td>
</tr>
<tr>
<td>Term test 1</td>
<td>10%</td>
<td>Individual</td>
<td>Oct. 16th</td>
<td>Oct. 16th</td>
</tr>
<tr>
<td>Term test 2</td>
<td>10%</td>
<td>Individual</td>
<td>Nov. 17th</td>
<td>Nov. 17th</td>
</tr>
<tr>
<td>Lab 1</td>
<td>5%</td>
<td>Team</td>
<td>Week of Oct. 12th</td>
<td>One week from the date, lab data received</td>
</tr>
<tr>
<td>Lab 2</td>
<td>5%</td>
<td>Team</td>
<td>Week of Oct. 26th</td>
<td>One week from the date, lab data received</td>
</tr>
<tr>
<td>Lab 3</td>
<td>5%</td>
<td>Team</td>
<td>Week of Nov. 16th</td>
<td>One week from the date, lab data received</td>
</tr>
</tbody>
</table>
The following course-specific policies will be strictly enforced throughout the course:

**Computer Requirements**

- All students are to ensure that they have a functional camera and microphone connected to their computer (irrespective of Windows or Mac-based). These two accessories will be required for all term tests, final exam as well as when asking questions during synchronous/live sessions or when working on in-tutorial problems.

**Remote Proctoring**

- The primary intent is to use Proctortrack as the sole remote proctoring solution throughout the course. However, if certain temporary difficulties will prevent the use of Proctortrack, Zoom might be used as an alternative term test/exam invigilation tool.
- If Zoom will be used for term test/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: [https://www.uwo.ca/univsec/pdf/onlineproctorguidelines.pdf](https://www.uwo.ca/univsec/pdf/onlineproctorguidelines.pdf)
- The complete hardware specifications for Proctortrack-monitored tests are listed here: [https://www.proctortrack.com/tech-requirements/](https://www.proctortrack.com/tech-requirements/)

**Online Class Demeanor/Netiquette**

The components of this course will involve online interactions. To ensure the best experience for both yourself and your classmates, please abide the following rules:

- All live sessions will take place via Zoom meetings. The links to be accessed for each class will be posted in the OWL calendar of the course.
- You will be required to authenticate in the Zoom meeting with your Western credentials only (SSO authentication on the westernuniversity.zoom.us domain). In the event you will authenticate in the Zoom meeting with different credentials, you will be removed from the online session without any warning.
- Please ensure that your Zoom participant name matches the one from the official class roster. Failure to do so will mean that you will be removed from the online session without any warning.
- Please connect on time into the Zoom session.
- Please use a Windows or Mac computer to connect to the Zoom meeting as opposed to a mobile device (i.e., cell phone or tablet).
- Please ensure that you are in a private location to protect the confidentiality of the class discussions (if applicable).
- To minimize the background noise, please mute your microphone for the duration of class.
- Please unmute your microphone only if invited to speak. Failure to do so might attract your immediate removal from the meeting.
• Please do not share your screen during the meeting unless asked by the instructor.
The course instructor will act a moderator of the online live session and will attempt
to answer the questions received from Zoom meeting participants. In this regard,
please consider the following:
• If you wish to speak during the live meeting, please use the “raise hand” feature
in Zoom and wait for the instructor to nominate you to speak.
• Zoom keeps track of the order in which the “raise hand” feature was activated by
each participant. Meeting participants will be asked to speak in the Zoom
indicated order.
• Please remember to unmute your microphone and turn on your video camera (if
turned off) before speaking.
• Please self-identify yourself at the beginning of your comment.
• Please remember to mute your microphone (unless directed otherwise).
• Please turn off your “blue virtual hand” after speaking.

Some general considerations pertaining “netiquette”:
• Please be mindful of the possibly different cultural and linguistic background of
Zoom meeting participants.
• Be courteous with all Zoom meeting participants.
• Be respectful of the diversity of viewpoints that you will encounter in the class
since the exchange of diverse ideas and opinions is an essential component of the
academic environment. However, please keep in mind that “flaming” is an
inacceptable behavior.
• Be professional in all online postings and questions.
• Please note that disruptive behavior of any type to occur 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 covered by the Code of Student Conduct.

Laboratory sessions
• All students are to attend the laboratory session to which they signed up.
• Online laboratory sessions will take place during preannounced weeks of the term
(schedule to be posted).
• Laboratory sessions will be held via scheduled Zoom sessions.
• Failure to pass the laboratory component of the course will attract automatic
course failure.
• Passing of the laboratory component is equivalent with obtaining more than 50%
on the laboratory component of the course.
• A maximum of one make-up session will be offered to students who have missed
a laboratory session with academic consideration.
• All approved make-up laboratory sessions will be offered in the final week of the
term.
• Missing of a laboratory session without academic consideration will translate into
a mark of zero for that laboratory session.
• When academic consideration has been obtained for a particular laboratory
session, it is the student’s responsibility to contact the instructor of the course in a
timely fashion in order to seek alternate arrangements for the missed laboratory
session (i.e., within maximum three days after consideration has been obtained from the Engineering Undergraduate Services Office).

- After all labs are done, **one face-to-face assessment** with each lab group. The mark obtained in the oral assessment for each group member will supersede the one obtained for the lab work. If the student denies his/her participation in the oral examination, the lab work will be automatically graded with zero.

- Students are required to contact the instructor of the course for any other circumstances that appear to not be covered by the non-exhaustive list above.

**Term Tests**

- The time of each term test will be posted.
- Term tests will be closed book, administered in OWL and will be proctored by means of the remote proctoring solution adopted by Western (i.e. Proctortrack).
- Each of the two term tests will be two hours long.
- **No make-up term test option will be offered regardless of the circumstances for which the term test was missed.**

  - Missing of a term test **without** academic consideration will translate into a mark of zero for that term test.
  - Missing the term test **with** academic consideration will automatically shift the weight of the missed term test into the final exam.
  - If technical issues will prevent a student from successfully completing and submitting the term test, the weight of the term test will be automatically shifted to the final exam.
  - If cheating during the term test is suspected, the student will be required to participate in a one-on-one oral examination with the instructor. The mark obtained in the oral examination will supersede the one obtained during the written term test. If the student denies his/her participation in the oral examination, the term test will be automatically graded with zero and further academic penalties for scholastic offences will be applied.
  - Students are required to contact the instructor of the course for any other circumstances that appear not to be covered by the non-exhaustive list above.

**In-Tutorial Assignments**

- In-tutorial assignments will take place during the second hour of the tutorials (dates specified above) where the first hour will consist of help session and practice problem solving conducted by the course instructor and/or the teaching assistant.
- The in-tutorial assignment will consist of problems to be solved by the team formed by the course instructor. For this purpose, the class will be split in Zoom breakout rooms, each of the rooms enclosing one team only.
- No make-up sessions will be offered for those missing the in-tutorial assignment (irrespective of the reason).
- If the in-tutorial assignment is missed **with** academic consideration, then its weight will be equally distributed into the rest of in-tutorial assignments.
- If the in-tutorial assignment is missed **without** academic consideration, then the mark for the missed exercise will be zero.
- Unlike term tests or final exams that require the approval of the Engineering Undergraduate Services, for in-tutorial assignments academic consideration should be obtained from the MME Undergraduate Coordinator.
• Students are required to contact the instructor of the course for any other circumstances that appear to not be covered by the non-exhaustive list above.

Term work

• If a minimum of 50% is not obtained on term work (class participation, term tests, in-tutorial assignments, and laboratory sessions), the student will fail the course irrespective of the mark obtained in the final examination.

Final examination

• The exam will take place during the December examination period. Its timing will be announced in advance.
• The exam will be closed book, delivered via OWL and proctored via Proctortrack.
• The length of the final exam will be three hours.
• If a minimum of 50% is not obtained on the final examination, the student cannot receive a final mark greater than 48%.
• If technical issues will prevent a student from successfully completing and submitting the final exam, the official guidelines from Associate Dean’s Office, Undergraduate Affairs will be followed. Options to be considered will include but without being limited to oral examination or make-up examination in the special examination period.
• If cheating during the final examination is suspected, the student will be required to participate in a one-on-one oral examination with the instructor. The mark obtained in the oral examination will supersede the one obtained during the written exam. If the student denies his/her participation in the oral examination, the final exam will be automatically graded with zero and further academic penalties for scholastic offences will be applied.
• Students are required to contact the instructor of the course for any other circumstances that appear to not be covered by the non-exhaustive list above.

Submissions

• In-tutorial assignments are due at the end of the tutorial hour in which they were assigned. No late submissions will be accepted.
• Lab reports will be due one week after the date on which data was provided. No late submissions will be accepted.

Students are required to contact the instructor of the course for any other circumstances that appear to not be covered by the non-exhaustive list above.

CONSULTATION HOURS: By appointment via email

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 the improper use of English. Additionally, poorly written work with the exception of final examinations 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.

ATTENDANCE: Any student who, in the opinion of the instructor, is absent too frequently from class or laboratory periods in any course, 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 examination in the course.
CHEATING: University policy states that cheating, including plagiarism, is a scholastic offense. The commission of a scholastic offence is attended by academic penalties which might include expulsion from the program. If you are caught cheating, there will be no second warning. (see Scholastic Offence Policy in the Western Academic Calendar).

SSD: 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. You may also wish to contact Services for Students with Disabilities (SSD) at 661-2111 x 82147 for any specific question regarding an accommodation.

NOTE: Students who have failed an Engineering course (i.e. < 50%) 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 for grading by the student in subsequent years.