

MME 3303a - Fluid Mechanics II

COURSE OUTLINE – 2022-2023

**CALENDAR
DESCRIPTION:**

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

**COURSE
INFORMATION:**

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

Lectures: W, 8:30-9:30 (SEB-1200)
Th, 8:30-9:30 (SEB-2100)
F, 2:30-3:30 (SEB-2100)

Tutorials: W, 9:30-11:30 (WSC-55)

Labs: **003** – M, 3:30-6:30 (SEB-1072)
004 – Th, 9:30-12:30 (SEB-1072)
005 – Th, 3:30-6:30 (SEB-1072)
006 – F, 9:30-12:30 (SEB-1072)
007 – M, 6:30-9:30 (SEB-1072)
008 – Tu, 1:30-4:30 (SEB-1072)

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. Introduction
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 (KB2, KB3, KB4, LL1)
 2. Solve governing equations of fluid mechanics for various geometrical configurations (PA1, PA2, PA3)
 3. Develop non-dimensional parameters for generalized parametric analysis (PA1, PA2, PA3)
 4. Predict the performance of a full-scale prototype based on model testing (PA2, PA3, I2, I3)
 5. Compute drag and lift forces on a wide range of objects (PA2)
 6. Interpret pump characteristic curves and evaluate pump's performance (PA2, PA3)
 7. Analyze and interpret data from lab experiments in relation to theoretical/empirical predictions (IN3)
 8. Participate in teamwork and evaluate self/peer performance in team (ITW3)

CONTACT HOURS:

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

TEXT:

Fluid Mechanics, Frank White, Eighth or Ninth edition, McGraw Hill.

REFERENCES:

Fundamentals of Fluid Mechanics. Munson, Young and Okiishi, Wiley.

UNITS:

Both SI and Imperial units.

EVALUATION:

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

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

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

| Evaluation Format | Weight | Effort Type | Assigned | Due |
|-------------------------|--------|-------------|--|--|
| Class participation | 10% | Individual | Weekly | During the lecture (5% for correct answers and 5% for participation) |
| In-tutorial assignments | 10% | Team | Weekly except Sept. 14, and Nov. 2 | End of tutorial hour in which it is assigned |
| Term test 1 | 15% | Individual | Oct. 17 (7:00-9:00 pm) | Room: TBD |
| Term test 2 | 15% | Individual | Nov. 14 (7:00-9:00 pm) | Room: TBD |
| Lab 1 | 5% | Team | Weeks of Oct. 11 th and Oct. 17 th | One week from the date of your lab |
| Lab 2 | 5% | Team | Weeks of Oct. 24 th and Nov. 7 th | One week from the date of your lab |
| Lab 3 | 5% | Team | Weeks of Nov. 14 th and Nov. 21 st | One week from the date of your lab |

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|-------|----|------|-------------------------------|------------------------------------|
| Lab 4 | 5% | Team | Week of Nov. 28 th | One week from the date of your lab |
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COURSE POLICIES

The following course-specific policies will be strictly enforced throughout the course:

Laboratory sessions

- All students are to attend the laboratory section to which they signed up.
- Lab schedule will be posted 2-3 weeks before the beginning of labs.
- 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 make-up session will be offered to students who have missed a laboratory session **with** academic consideration.
- 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).
- Missing more than one lab without academic consideration will result in the course failure.
- 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

- Term tests will be closed book (formula sheet will be provided. Standard scientific calculators are permitted).
- 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.
- 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.
- No make-up sessions will be offered for those missing the in-tutorial assignment (irrespective of the reason).
- The grading for in-tutorial assignments will be based on the **best n-1** of *n* in-tutorial assignments scheduled during the course.
- 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.

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- 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.
- The exam will be closed book (formula sheet will be provided. Standard scientific calculators are permitted).
- The length of the final exam will be three hours.
- If a minimum of 50% is not obtained on the final examination, the student will be assigned a grade of no greater than 48% for the course.
- If you miss the Final Exam, please contact the Academic Counselling office in the Engineering Undergraduate Services as soon as you are able to do so. 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).
- 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 the lab was performed. 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. Email the instructor to schedule a consultation.

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.

SSD:

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.

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.

**ACCOMMODATION
& 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 in the Engineering Undergraduate Services. Please consult University's list of recognized religious holidays (updated annually) at

<https://multiculturalcalendar.com/ecal/index.php?s=c-univwo>.

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.

**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:

http://www.uwo.ca/univsec/pdf/academic_policies/appeals/scholastic_discipline_undergrad.pdf.

If you are caught cheating, there will be no second warning.

iClicker will be used for class participation. Students need to provide answers to the questions shared during the lecture. Students must complete the iClicker assessments in the classroom. Each student must complete and submit their own assessments. The data gathered from iClicker will only be accessed and used by the instructor to evaluate students' participation and class presence.

**SUPPORT
SERVICES**

Please visit the 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

https://www.uwo.ca/health/student_support/survivor_support/get-help.html.

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

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.

Additional student-run support services are offered by the USC, <https://westernusc.ca/services/>.