

**Western University
Faculty of Engineering
Department of Mechanical and Materials Engineering**

**MSE 2273b: INTRODUCTION TO FLUID MECHANICS
AND HEAT TRANSFER**

Course Outline 2023-24

Description: An introduction to fluid mechanics and heat transfer. The fluid mechanics part covers fluid properties, fluid statics including buoyancy and stability, one-dimensional fluid dynamics including conservation of mass and energy and losses in pipe networks. Heat transfer covers development of the general energy equation for three dimensions and steady-state conduction in one and two dimensions.

Upon successful completion of this course students will be able to:

- (1) Combine and apply the concepts learned to accurately solve engineering calculation problems based on the fluid mechanics and heat transfer topics covered in the course.
- (2) Conduct laboratory experiments in fluid mechanics and heat transfer, analyze the data obtained and critically evaluate the results, including an assessment of sources of experimental uncertainty.

Instructor: Dr Eric Savory
SEB 3085, 519-661-2111 ext. 88256, UWO e-mail: esavory@uwo.ca
Consultation hours: To be determined

Academic Calendar Copy:

Contact Hours: 3 lecture hours, 2 tutorial hours, 0.5 laboratory hours per week (laboratory hours occur in two 3-hour sessions), 0.5 course.

Anti-requisite: None

Pre-requisites: NMM 2270A/B or the former Applied Mathematics 2270A/B

Co-requisite: NMM 2270A/B or the former Applied Mathematics 2270A/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.

CEAB Academic Units: Science = 50%, Engineering Science = 50%.

Required Textbooks:

For Fluid Mechanics: *Fluid Mechanics*, White F and Xue H, 9th Edition, McGraw Hill, ISBN 978-1-260-57554-5.

For Heat Transfer: *Fundamentals of Heat and Mass Transfer*, Bergman T L, Lavine A S, 8th Edition, John Wiley and Sons, ISBN: 978-1-119-32042-5.

Other Required References: Some additional material will be posted on the course OWL site.

General Learning Objectives (CEAB Graduate Attributes)

Knowledge Base (KB)	I	Use of Engineering Tools		Impact on Society and the Environment	
Problem Analysis (PA)	I	Individual and Teamwork	I	Ethics and Equity	
Investigation (I)	I	Communication Skills		Economics and Project Management	
Design		Professionalism		Life-Long Learning	

Notation: where x be I: Introductory, D: Intermediate, A: Advanced, or empty.

I – The instructor will introduce the topic at the level required. It is not necessary for the student to have seen the material before.

D – There may be a reminder or review, but the student is expected to have seen and been tested on the material before taking the course.

A – It is expected that the student can apply the knowledge without prompting (e.g. no review).

Course Topics and Specific Learning Outcomes	CEAB Graduate Attributes Indicators
<p>1. Fluid statics</p> <p>At the end of this section, students will be able to:</p> <ol style="list-style-type: none"> Identify the fluid properties required to solve a problem and determined their magnitude. Determine the pressure at a point in a static fluid from a measurement taken at another point. Quantify hydrostatic forces and moments acting on a system. Determine whether a partially submerged body will float and whether it will be stable. 	<p>KB2</p> <p>KB2, PA2</p> <p>KB3, PA2</p> <p>KB2, PA2</p>
<p>2. Fluid dynamics</p> <p>At the end of this section, students will be able to:</p> <ol style="list-style-type: none"> Apply the mass and energy conservation (Bernoulli) equations to solve idealized fluid flow problems. Determine flow rates and or pressure losses in a realistic pipe system. Successfully conduct and report on laboratory measurements taken on a pipe flow system. 	<p>KB2, KB3</p> <p>KB2, KB3, PA2</p> <p>I2, I3</p>

<p>3. Introduction to heat transfer modes</p> <p>At the end of this section, students will be able to:</p> <ol style="list-style-type: none"> Identify the modes of heat transfer associated with a given heat transfer problem. Calculate heat transfer rates and/or material/fluid temperatures for simple problems involving two or three heat transfer modes. 	<p>KB2</p> <p>KB3</p>
<p>4. Steady state conduction</p> <p>At the end of this section, students will be able to:</p> <ol style="list-style-type: none"> Apply the heat diffusion equation to solve 1-D conduction problems in Cartesian, cylindrical and spherical co-ordinate systems. Successfully conduct and report on laboratory measurements of linear conduction heat transfer Determine the heat transfer characteristics of a finned surface. Use shape factors to solve simple multi-dimensional heat transfer problems. 	<p>KB3, PA2</p> <p>I2, I3</p> <p>KB3, PA2</p>

Evaluation:

Course Component	Weight
In-tutorial Questions	8% (1.6% each)
Quizzes	27% (13.50% each)
Laboratory	5% (2.50% each)
Final Examination	60%

In-tutorial Questions:

- In-tutorial Question #1: Tuesday 23rd January 2024
- In-tutorial Question #2: Tuesday 30th January 2024
- In-tutorial Question #3: Tuesday 13th February 2024
- In-tutorial Question #4: Tuesday 27th February 2024
- In-tutorial Question #5: Tuesday 12th March 2024
- In-tutorial Question #6: Tuesday 19th March 2024
- In-tutorial Question #7: Tuesday 26th March 2024

Quizzes:

- Quiz #1: Tuesday 6th February 2024, 8.40 am – 10.10 am
- Quiz #2: Tuesday 5th March 2024, 8.40 am – 10.10 am

Laboratories:

- Laboratory experiment 1: Losses in pipe networks (Weeks 9 – 11)
- Laboratory experiment 2: Linear heat conduction (Weeks 10 – 12)

Final Examination: The final examination will take place during the regular examination period.

Course Policies

General: Students are responsible for regularly checking their Western e-mail and the OWL course website (<https://owl.uwo.ca/portal/>) in order to make themselves aware of any information that is posted about the course. If a student fails to act on information that has been posted on the OWL course website and does so without a legitimate explanation (i.e. those covered under the illness/compassionate form), then there are no grounds for an appeal.

Quizzes: Both Quizzes will be closed book and an equation sheet will be provided in the exam. Only non-programmable calculators will be allowed. Students arriving more than 30 minutes late for a Quiz will not be allowed to write the Quiz and will receive zero marks. If a student is excused from writing a Quiz by academic consideration (e.g. due to illness), the weighting of that Quiz will be placed onto the Final Exam. If a student is going to miss, or require accommodations for, a Quiz for religious reasons, they must inform the instructor in writing within 1 week of the start of the term or they will be required to write the Quiz. Even with academic consideration (see above) a student must attend and submit work for at least 1 of the 2 Quizzes to be eligible to sit the final exam. There will be no makeup Quiz.

Weekly In-tutorial Questions: The In-tutorial Questions are open-book and students must work in a group of 4 students, submitting a single solution with all the group members' names and ID numbers on it. Students arriving more than 30 minutes late for an In-tutorial Question will not be allowed to be included on a submitted solution and will receive zero marks. Weekly In-tutorial Questions must be submitted in a group of four for marking. Individual students must also submit their own work on the problem; failure to complete both steps may result in a grade of zero. Even with any academic considerations (see above), a student must attend and submit work for a minimum of 4 out of the 7 In-tutorial Questions in order to be eligible to sit the final exam. The total course grade for In-tutorial Questions is based on the student's best five submissions. A question missed with academic consideration will be one of the dropped marks; for example, if a student is excused from two questions and skips one, the excused questions will be dropped and the grade of 0 from the skipped question will count in the final mark. The weight of In-tutorial Questions will not be redistributed unless the student is excused with academic consideration from three missed questions; in this case, the in-tutorial question grade will be calculated from the four submitted questions.

Laboratories: Laboratory reports are to be submitted during the same laboratory class in which the experiment is completed. Attendance at both of the designated laboratory sessions is compulsory (even with academic consideration). Failure to attend and complete both laboratory sessions will mean that the student will not be allowed to sit the final exam. If a laboratory is missed without academic consideration, there is no guarantee of a make-up laboratory session. If remote delivery of the course is occurring or appears likely (as determined by the instructor) to occur during weeks 9-12, an alternative at-home lab format will be used. If at-home labs are assigned with a week or more between the date they are assigned and the date they are due, students who receive academic consideration for the date the lab is due must submit their lab within forty-eight hours of the original deadline. Late labs will not be accepted.

Final Exam: The final exam will be closed-book and an equation sheet will be provided. Only non-programmable calculators will be allowed. If a minimum mark of 50% is not obtained on the final exam the student cannot receive a final course mark greater than 48%. Students arriving more than 30 minutes late for an in-person exam will not be allowed to write the exam and will receive zero marks. Students arriving late for an on-line exam will not be allowed to write the exam and will receive a mark of zero.

Summary of Attendance and Coursework Submission Policies: Even taking into account any academic considerations, in order to be able to sit the Final Exam a student must:

(1) Attend and submit solutions for at least 4 of the 7 In-tutorial questions;

(2) Attend and submit work for at least 1 of the 2 Quizzes and

(3) Attend and submit work for both of the laboratory sessions.

Any student not meeting these requirements will be forbidden to write the final exam and so will fail the course. In the absence of academic consideration, it is necessary to submit work for 5 in-tutorial questions and sit both quizzes to have the opportunity to gain full marks in those categories. Late assessments will not be accepted, and the student will receive a zero on assessments that are not submitted unless the student has academic consideration. There will be no makeup quizzes.

Use of English and Communication: 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.

Students are required to behave professionally during all class meetings. Failure to comply may result in the student receiving a grade of zero on any associated grades or assessments occurring at the time of the infraction.

Absence Due to Illness or Other Circumstances: Students should immediately consult with the instructor or department Chair if they have any problems that could affect their performance in the course. Where appropriate, the problems should be documented (see the attached “Instructions for Students Unable to Write Tests or Examinations or Submit Assignments as Scheduled”). The student should seek advice from the instructor or department Chair regarding how best to deal with the problem. Failure to notify the instructor or department Chair immediately (or as soon as possible thereafter) will have a negative effect on any appeal.

For more information concerning medical accommodations, see the relevant section of the Academic Handbook:

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

For more information concerning accommodations for religious holidays, see the relevant section of the Academic Handbook:

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

Cheating and Plagiarism: Students must write their essays and assignments in their own words. Whenever students take an idea or a passage from another author, they must acknowledge their debt both by using quotation marks where appropriate and by proper referencing such as footnotes or citations. University policy states that cheating, including plagiarism, is a scholastic offence. 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.

All required papers may be subject to submission for textual similarity review to commercial plagiarism-detection software under license to the University for the detection of plagiarism. All papers submitted will be included as source documents on the reference database for the purpose of detecting plagiarism of papers subsequently submitted to the system. Use of the service is subject to the licensing agreement, currently between the University of Western Ontario and Turnitin.com (<http://www.turnitin.com>).

Students may not upload course materials to the internet. Students are prohibited from submitting course questions to on-line tutoring services, discussion boards, etc. Violation of this rule will be considered a scholastic offence and may result in a grade of zero on associated work, even if the question was uploaded after the end of the assessment.

Students must follow all proctoring rules, which may be given in an OWL announcement, orally during a synchronous or in person class meeting, directly on the assessment question sheet, or through other means. Failure to comply to proctoring rules will result in a penalty of up to or including receiving a grade of zero on the affected assessment.

Scholastic offences are taken seriously and students are directed to read the appropriate policy, specifically, the definition of what constitutes a Scholastic Offence, in the relevant section of the Academic Handbook:

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

Course delivery with respect to the COVID-19 pandemic: Although the intent is for this course to be delivered in-person, the changing COVID-19 landscape may necessitate some or all of the course to be delivered 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 except as noted in the syllabus. Any assessments affected will be conducted online in a manner determined by the course instructor. Students may be required to turn on their cameras and/or microphones during synchronous remote lessons, tutorials, or assessments.

When deemed necessary (by the instructor, department, and/or faculty), tests and examinations in this course will be conducted using a remote proctoring service. By taking this course, you are consenting to the use of this software and acknowledge that you will be required to provide personal information (including some biometric data) and the session will be recorded. Completion of this course will require you to have a reliable internet connection and a device that

meets the technical requirements for this service (including a microphone and a camera). More information about remote proctoring services, including technical requirements, is available on Western's Remote Proctoring website at: <https://remoteproctoring.uwo.ca>.

Use of Electronic Devices: Only a non-programmable calculator may be used in the Quizzes and in the Final Exam.

Use of Personal Response Devices (“Clickers”): None.

Policy on Repeating All Components of a Course: Students who are required to repeat an Engineering course 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 by the student for grading in subsequent years.

Internet and Electronic Mail: Students are responsible for regularly checking their Western e-mail and the course web site (<https://owl.uwo.ca/portal/>) and making themselves aware of any information that is posted about 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. You may also wish to contact Services for Students with Disabilities (SSD) at 519-661-2111 ext. 82147 for any specific question regarding an accommodation.

Support Services: Office of the Registrar, <http://www.registrar.uwo.ca/>
Student Development Centre, <http://www.sdc.uwo.ca/>
Engineering Undergraduate Services, <http://www.eng.uwo.ca/undergraduate/>
USC Student Support Services, <http://westernusc.ca/services/>

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

es / 03 January 2024

STATEMENT ON GENDER-BASED AND SEXUAL VIOLENCE

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 gender-based or sexual violence (either recently or in the past), you will find information about support services for survivors, including emergency contacts, [here](#). To connect with a case manager or set up an appointment, please contact support@uwo.ca.

INSTRUCTIONS FOR STUDENTS UNABLE TO WRITE TESTS OR EXAMINATIONS OR SUBMIT ASSIGNMENTS AS SCHEDULED

If, on medical or compassionate grounds, you are unable to write term tests or final examinations or complete course work by the due date, you should follow the instructions listed below. You should understand that academic relief will not be granted automatically on request. You must demonstrate to your department (or the Undergraduate Services Office) that there are compelling medical or compassionate grounds that can be documented before academic relief will be considered. Different regulations apply to term tests, final examinations and late assignments. Please read the instructions carefully.

A. GENERAL REGULATIONS & PROCEDURES

1. All first-year students will report to the Undergraduate Services Office by submitting the [Academic Consideration Request Form](#), for all instances.
2. If you are an upper year student and you are missing a test/assignment/lab or examination you will report the absence by submitting [Academic Consideration Request Form](#). Absences worth LESS THAN 10% of your mark, will be processed by your department office. If your course work is worth 10% OR MORE of your final grade, your request will be processed by the Undergraduate Services Office.
3. Check the course outline to see if the instructor has a policy for missed tests, examinations, late assignments or attendance.
4. Documentation must be provided as soon as possible. If no one is available in your department office or the Undergraduate Services Office, leave a message clearly stating your name & student number and reason for your call. The department telephone numbers are given at the end of these instructions.
5. If you decide to write a test or an examination you should be prepared to accept the mark you earn. Rewriting tests or examinations or having the value of a test or examination reweighted on a retroactive basis is not permitted.

B. TERM/MIDTERM TESTS

1. If you are in first year and you are unable to write a midterm/term test, contact the Undergraduate Services Office, SEB 2097 PRIOR to the scheduled date of the test.
2. If you are an upper year student and you are unable to write a midterm/term test, inform your instructor PRIOR to the scheduled date of the test and request relief through the [Academic Consideration Request Form](#). If the instructor is not available, leave a message for him/her at the department office. If the test is worth LESS THAN 10% of your mark, your request for relief will be processed by your department office. If the test is worth MORE THAN 10% of your final grade your request for relief will be processed by the Undergraduate Services Office.
3. Be prepared to attach supporting documentation to the Department Chair and/or the Undergraduate Services Office through the online form (see next page for information on documentation).

Discuss with the instructor if and when the test can be rescheduled. The approval of the Chair or the Undergraduate Services Office is required when rescheduling midterm/term tests.

FINAL EXAMINATIONS

1. If you are unable to write a final examination, contact the Undergraduate Services Office PRIOR TO THE SCHEDULED EXAMINATION TIME to report your absence using the [Academic Consideration Request Form](#) and request permission to write a Special Final Examination. If no one is available in the Undergraduate Services Office, leave a message clearly stating your name & student number.
2. Be prepared to provide the Undergraduate Services Office with supporting documentation (see next page for information on documentation) the next day, or as soon as possible (in cases where students are hospitalized). The following circumstances are not considered grounds for missing a final examination or requesting special examinations: common cold, headache, sleeping in, misreading timetable and travel arrangements.
3. In order to receive permission to write a Special Examination, you must obtain the approval of the Chair of the Department **and** the Associate Dean and in order to apply you must submit an "[Application for a Special Exam](#)" form. The Undergraduate Services Office will then notify the course instructor(s) and reschedule the examination on your behalf.

PLEASE NOTE: It is the student's responsibility to check the date, time and location of the Special Examination.

D. LATE ASSIGNMENTS

1. Advise the instructor if you are having problems completing the assignment on time (**prior** to the due date of the assignment).
2. Be prepared to submit the [Academic Consideration Request Form](#) and provide documentation if requested by the instructor (see reverse side for information on documentation).
3. If you are granted an extension, establish a due date. The approval of the Chair of your Department (or the Assistant Dean, First Year Studies, if you are in first year) is not required if assignments will be completed prior to the last day of classes.
4.
 - i) Extensions beyond the end of classes must have the consent of the instructor, the department Chair and the Associate Dean, Undergraduate Studies. Documentation is mandatory.
 - ii) A Recommendation of Incomplete Form must be filled out indicating the work to be completed and the date by which it is due. This form must be signed by the student, the instructor, the department Chair and the Associate Dean, Undergraduate Studies.

E. SHORT ABSENCES

If you miss a class due to a minor illness or other problem, check your course outlines for information regarding attendance requirements and make sure you are not missing a test, laboratory or assignment. Cover any readings and arrange to borrow notes from a classmate.

F. EXTENDED ABSENCES

If you are absent more than one week or if you get too far behind to catch up, you should consider reducing your workload by dropping one or more courses. (Note drop deadlines listed below). You are strongly encouraged to seek advice from your Academic Counsellor in the Undergraduate Services Office.

G. DOCUMENTATION

If you consulted an off-campus doctor or Student Health Services regarding your illness or personal problem, **you must provide the doctor with a Student Medical Certificate** to complete at the time of your visit and then bring it to the Department (or the Undergraduate Services Office). **This note must contain the following information: severity of illness, effect on academic studies and duration of absence. Regular doctor's notes will not be accepted; only the Student Medical Certificate will be accepted.**

In Case of Serious Illness of a Family Member: Provide a Student Medical Certificate to your family member's physician to complete and bring it to the Department (or the Undergraduate Services Office if you are in first year).

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 bring it to the Department (or the Undergraduate Services Office if you are in first year).

For Other Extenuating Circumstances: If you are not sure what documentation to provide, ask the Departmental Office (or the Undergraduate Services Office if you are in first year) for direction.

Note: Forged notes and certificates will be dealt with severely. To submit a forged document is a scholastic offence (see below).

ACADEMIC CONCERNS

1. You need to know if your instructors have a policy on late penalties, missed tests, etc. This information may be included on the course outlines. If not, ask your instructor(s).
2. You should also be aware of attendance requirements in some courses. You can be debarred from writing the final examination if your attendance is not satisfactory.
3. If you are in academic difficulty, check out the minimum requirements for progression in the calendar. If in doubt, see your Academic Counsellor.

Calendar References: Check these regulations in your 2023 Western Academic Calendar available at www.westerncalendar.uwo.ca.

Absences Due to Illness:

http://www.westerncalendar.uwo.ca/PolicyPages.cfm?Command=showCategory&PolicyCategoryID=1&SelectedCalendar=Live&ArchiveID=#Page_135

Academic Accommodations for Students with Disabilities:

http://www.westerncalendar.uwo.ca/PolicyPages.cfm?Command=showCategory&PolicyCategoryID=1&SelectedCalendar=Live&ArchiveID=#Page_10

Academic Accommodations for Religious or Holy Days:

http://www.westerncalendar.uwo.ca/PolicyPages.cfm?Command=showCategory&PolicyCategoryID=1&SelectedCalendar=Live&ArchiveID=#Page_16

Course Withdrawals:

http://www.westerncalendar.uwo.ca/PolicyPages.cfm?Command=showCategory&PolicyCategoryID=6&SelectedCalendar=Live&ArchiveID=#Page_75

Examinations:

<http://www.westerncalendar.uwo.ca/PolicyPages.cfm?PolicyCategoryID=5&command=showCategory&SelectedCalendar=Live&ArchiveID=>

Scheduling of Term Assignments:

http://www.westerncalendar.uwo.ca/PolicyPages.cfm?Command=showCategory&PolicyCategoryID=5&SelectedCalendar=Live&ArchiveID=#SubHeading_78

Scholastic Offences:

http://www.westerncalendar.uwo.ca/PolicyPages.cfm?Command=showCategory&PolicyCategoryID=1&SelectedCalendar=Live&ArchiveID=#Page_20

Student Medical Certificate:

<http://www.eng.uwo.ca/files/undergraduate/student-medical-certificate.pdf>

Engineering Academic Regulations:

http://www.westerncalendar.uwo.ca/PolicyPages.cfm?Command=showCategory&PolicyCategoryID=4&SelectedCalendar=Live&ArchiveID=#Page_86

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.

Add Deadlines:

First term half course (i.e. “A” or “F”)	September 15, 2023
Full courses and full-year half course (i.e. “E”, “Y” or no suffix)	September 15, 2023
Second term half course (i.e. “B” or “G”)	January 16, 2024

Drop Deadlines:

First term half course without penalty (i.e. “A” or “F”)	November 13, 2023
Full courses and full-year half courses without penalty (i.e. “E”, “Y” or no suffix)	November 30, 2023
Second term half or second term full course without penalty (i.e. “B” or “G”)	March 7, 2024

Contact Information:

Undergraduate Services Office: SEB 2097 Phone: 519-661-2130
E-mail: engugrad@uwo.ca

Chemical & Green Process Engineering: TEB 477 Phone: 519-661-2131
E-mail: cbeugrad@uwo.ca

Civil Engineering: SEB 3005 Phone: 519-661-2139
E-mail: civil@uwo.ca

Computer, Electrical, Mechatronic Systems & Software Engineering TEB 279 Phone: 519-661-3758
E-mail: eceugrad@uwo.ca

Integrated Engineering ACEB 2410 Phone: 519-661-6725
E-mail: engceli@uwo.ca

Mechanical Engineering: SEB 3002 Phone: 519-661-4122
E-mail: mmeundergraduate@uwo.ca