Western University
Faculty of Engineering
Department of Mechanical and Materials Engineering

MME 2273b: INTRODUCTION TO FLUID MECHANICS AND HEAT TRANSFER

Course Outline 2024-25

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. K. Ogden
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Consultation hours: To be determined

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.
Fluid Mechanics
This textbook is typically also used for MME3303, so I do not recommend a short-term subscription, which may expire before you are finished both courses. Page numbers, subsection numbers, and suggested practice problems from the textbook may be numbered differently, but previous versions are otherwise acceptable. I will not assign problems from the textbook to be handed in for grading.

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.
Fundamentals of Heat and Mass Transfer, 8th Edition | Wiley
This textbook is typically also used for MME3307, so I do not recommend a short-term subscription, which may expire before you are finished both courses. In the past, MME3307 has allowed use of the physical textbook during tests, although I cannot make any guarantee that this will continue, so take this into account when deciding which format to purchase. Page numbers, subsection numbers, and suggested practice problems from the textbook may be numbered differently, but previous versions are otherwise acceptable. I will not assign problems from the textbook to be handed in for grading.

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

General Learning Objectives (CEAB Graduate Attributes)

The Mechanical and Materials Engineering Program has been accredited by Canadian Engineering Accreditation Board (CEAB) of Engineers Canada. Accredited programs provide the academic requirements for licensure as a professional engineer in Canada. Western Engineering has defined indicators of the 12 Graduate Attributes (GAs) that the CEAB expects graduating engineering students to demonstrate. The connections between course learning outcomes and Western Engineering's GA Indicators are identified below.

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**
1. Fluid statics At the end of this section, students will be able to: **a.** Identify the fluid properties required to solve a problem and determined their magnitude.	KB2

b. Determine the pressure at a point in a static fluid from a measurement taken at another point.	KB2, PA2
c. Quantify hydrostatic forces and moments acting on a system.	KB3, PA2
d. Determine whether a partially submerged body will float and whether it will be stable.	KB2, PA2
2. Fluid dynamics	
At the end of this section, students will be able to:	
a. Apply the mass and energy conservation (Bernoulli) equations to solve idealized fluid flow problems.	KB2, KB3
b. Determine flow rates and or pressure losses in a realistic pipe system.	KB2, KB3, PA2
c. Successfully conduct and report on laboratory measurements taken on a pipe flow system.	I2, I3
3. Introduction to heat transfer modes	
At the end of this section, students will be able to:	
a. Identify the modes of heat transfer associated with a given heat transfer problem.	KB2
b. Calculate heat transfer rates and/or material/fluid temperatures for simple problems involving two or three heat transfer modes.	KB3
4. Steady state conduction	
At the end of this section, students will be able to:	
a. Apply the heat diffusion equation to solve 1-D conduction problems in Cartesian, cylindrical and spherical co-ordinate systems.	KB3, PA2
b. Successfully conduct and report on laboratory measurements of linear conduction heat transfer	I2, I3
c. Determine the heat transfer characteristics of a finned surface.	
d. Use shape factors to solve simple multi-dimensional heat transfer problems.	KB3, PA2

Evaluation

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

In-tutorial Questions:

In-tutorial Question #1: Thursday 23rd January 2025
In-tutorial Question #2: Thursday 30th January 2025
In-tutorial Question #3: Thursday 13th February 2025
In-tutorial Question #4: Thursday 27th February 2025
In-tutorial Question #5: Thursday 13th March 2025
In-tutorial Question #6: Thursday 20th March 2025
In-tutorial Question #7: Thursday 27th March 2025

Quizzes:

Quiz #1: Thursday 6th February 2025 (week 5), 1.40 pm – 3.10 pm
Quiz #2: Thursday 6th March 2025 (week 8), 1.40 pm – 3.10 pm

Laboratories:

Laboratory experiment 1: Losses in pipe networks (Weeks 10 – 11)
Laboratory experiment 2: Linear heat conduction (Weeks 11 – 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://wts.uwo.ca/owl/) 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 (midterms): 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 an in-person 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, 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 meet the minimum coursework requirements (see Summary of Minimum Coursework Requirements Policies below). **Supporting documentation must be provided to obtain academic consideration to miss the first Quiz (held on February 6th, 2025).** There will be no makeup quizzes.

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 for marking with all the group members' names and ID numbers on it. Individual students must also submit their own work on the problem; failure to complete both steps may result in a grade of zero. 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. Students must attend and submit work for a minimum of 5 out of the 7 in-tutorial questions to meet the minimum coursework requirements (see Summary of Minimum Coursework Requirements Policies below). The total course grade for in-tutorial questions is based on the student's best five submissions. Due to the flexibility provided by the in-tutorial question

grade being based on five of seven assessments, academic consideration will not be granted for any missed tutorial.

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 meet the minimum coursework requirements (see Summary of Minimum Coursework Requirements Policies below). If a laboratory is missed without academic consideration, there is no guarantee of a make-up laboratory session. Students must contact the course instructor within 24 hours of a missed lab, or there is no guarantee of a make-up lab session. Under extenuating circumstances, as determined by the instructor, an alternative lab format may 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.

Summary of Minimum Coursework Requirements Policies: Even taking into account any academic considerations, a student must:
(1) Attend and submit solutions for at least 5 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 may not receive an overall course grade higher than 50%. In the absence of academic consideration, it is necessary to sit both quizzes to have the opportunity to gain full marks in that category. 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 Electronic Devices: Only a non-programmable calculator may be used in the Quizzes and in the Final Exam.

USE OF GENERATIVE ARTIFICIAL INTELLIGENCE (AI)

Students may use artificial intelligence to aid in learning course content. Students may *not* use artificial intelligence on any assessment or work that will be graded in the course.