MATH 4180/Math 6120/PHYS 4205
Introduction to Fluid Dynamics, Winter 2025

CONTACT INFORMATION

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(**All homework and report will be submitted through Brightspace** (online.mun.ca).)

MEETING

The class is scheduled on MWF from 10:00 to 10:50 in HH 3017

OFFICE HOUR

Tuesday 2:00-3:00 in HH3054 or mun.webex.com/meet/alamj/ or by appoitment

For all email communications, please use **subject: math 6120 or math 4180 or Phys 4205**.

PREREQUISITE

Official PR: Math 2260 (or former Math 3260) and Math 3202

MARKING SCHEME

Assignments	30%
Test (1 test, duration of 50 m, closed book, supervised)	20%
Project (Research plan)	05%
Project (Presentation)	10%
Final examination (3 hours, open-book)	35%

Term work will be determined by assignments and test.

Calendar description

(Same as Physics 4205). covers basic observations, mass conservation, vorticity, stress, hydrostatics, rate of strain, momentum conservation (Navier-Stokes equation), simple viscous and inviscid flows, Reynolds number, boundary layers, Bernoulli's and Kelvin's theorems, potential flows, water waves, thermodynamics.

Learning Goals

- understand the basic concepts of fluid dynamics, conservation principles, and the mathematical description of laminar and turbulent fluid flow.
- be able to explain fluid flow phenomena occuring in oil and gas, renewable energy, and weather forecasting.
- be able to compute fluid induced forces on bodies such as wind turbines, cars, airplanes, etc..
- be able to solve (analytical) viscous flow problems.
- be able to use software packages, such as numpy, matplotlib, etc in solution methods.
- be able to visualize fluid motion mathematically and/or graphically

COURSE OUTLINE

- **Review of basic concepts and derivation of equations** (chs.1-4)
- **Vorticity dynamics, inviscid flow, aerodynamics** (ch. 5, 6, 14)
- **Laminar flow and boundary layer** (chs. 9-10)
- **Gravity waves** (chs. 8)
- **Turbulence and Geophysical Fluid Dynamics** (chs. 13, 14)

The class is encouraged to utilize computational tools, such as matlab or python, to explore fluid flow, particularly in the calculation of solutions.

TEXTBOOK

Fluid Mechanics, 6th edition by Kundu, Cohen, and Dowling. This textbook will be followed to understand the material; however, the exercises at the end of each chapter are not required to be solved. Any other textbook may be used.

The textbook is available online, see

`http://www.sciencedirect.com/science/book/9780123821003)`

which can also be purchased from the bookstore. Library has printed copies of the book. Students may find lecture notes sufficient to pass the course.

Students are permitted to carry a physical copy of the textbook during the final examination to avoid memorization of the material and to focus on comprehensive learning. If a physical copy is not availble, students can print or photo copy up to 15 pages to use during the final examination. No class notes or other form of notes will be allowed to access during the examination.

ASSIGNMENTS

Failure to submit an assignment by the due date will be considered unsubmitted. Any academically acceptable accommodation will be assessed to ensure that everyone can learn by overcoming unexpected obstacles.

Tentative schedule of assignments:

1. Due date Jan 24, 2025 at 1159 (6% Homework 1)
2. Due date Feb 07, 2025 at 1159 (6% Homework 2)
3. Due date Feb 17, 2025 at 1159 (5% Written project proposal, 2-3 pages)
4. Due date Feb 21, 2025 at 1159 (6% Homework 3)
5. **Mid term** Mar 7, 2025 at 1000 (20% Closed book, invigilated)
6. Due date Mar 21, 2025 at 1159 (6% Homework 4)
7. Due date Apr 04, 2025 at 1159 (6% Homework 5)
8. Due date Apr (7,9), 2025 at 0000 (10% Presentation room, date, and time to be anounced)
9. Due date Apr xx, 2025 at xxxx (35% Open-book invigilated final exam, 3 hours)

PROJECT

The project is a directed research, which aims at further reading of the material related to a real-world problem in Fluid Mechanics.

Students will select a topic independently according to their academic research interests and by consultation with the course instructor to ensure its suitability. A short report of 2-3 pages must be submitted summarizing primary investigation.

The short report would cover the background, research objective, methodology, possible outcome, and a bibliography. The short report can justify the objective and questions based on the literature, briefly present the method and data that will be explored, indicate the possible analysis of the results.

Project may be any of the three types: a mathematical analysis, a literature review, or a computational simulation.

The presentation slides must be submitted for assessment. All student must participate in peer presentation.

The evaluation in presentation will be based on the formulation of the research question, knowledge of the methods chosen, interpretation of the results. Clarity of the slides and eye contact during presentation will also be considered.

FINAL EXAMINATION

Graduate version of the final examination will have at least 30% of the weight dealing with relatively challenging problems. However, the duration of the final examination remains the same for each group.

The final examination will cover the entire course material and this will be an open-book examination and written during the time-slot assigned in MUN's examination schedule. Any printed copy of the fluid dynamics book is allowed because equations and theorems are not supposed to be memorized. Three copies of the book (4th, 5th, 6th editions) will be made available to borrow on the day of the examination.

Accommodation:

Un-submitted assignments will be treated missed work because there is enough time between submission dates. For example, if sickness is the reason for not submitting an assignment, it will not be generally accepted unless the concerned student declare longtime sickness (no doctor's note is required, an email from the concerned student is required and will be sufficient.)

Any missed work due to justified academic reasons will be accommodated through the adjustment of weights with a similar evaluation item.

"Memorial University of Newfoundland is committed to ensuring an environment of understanding and respect for the dignity and worth of each student and also to supporting inclusive education based on the principles of equity, accessibility and collaboration". For more information on Memorial University's commitment to accommodation of students with disabilities, see https://www.mun.ca/policy/site/policy.php?id=239 .

Plagiarism and other academic misconduct:

Any instance of plagiarism or cheating or any other form of academic misconduct will be treated according to Section 6.12 of the University Calendar. Students are advised to consult the relevant sections for full details.

Note that section 6.12.4 includes the following statements of **Academic offenses**:

- **Impersonating** another student or allowing oneself to be impersonated: This includes the imitation of a student or the entrance into an arrangement with another person to be impersonated for the purposes of taking examinations or tests or carrying out laboratory or other assignments.
- **Plagiarism**: Plagiarism is the act of presenting the ideas or works of another as one's own. This applies to all material such as essays, laboratory assignments, laboratory reports, work term reports, design projects, seminar presentations, statistical data, computer programs, research results and theses. The properly acknowledged use of sources is an accepted and important part of scholarship. Use of such material without acknowledgment is contrary to accepted norms of academic behavior. Information regarding acceptable writing practices is available through the Writing Centre at www.mun.ca/writingcentre
- **Use of technology and external resources:** Use of any technology is allowed and encouraged as appropriate. These include software, grammar and spelling tools, word processing tools etc. However, the use of any Generative AI tools, such as ChatBot like tools, are not acceptable to prepare the submitted grading items.