

Mechanical Engineering
MECHENG 4S03
Incompressible Flow
Fall 2023



ENGINEERING

Instructor Information

Shakirudeen Salaudeen

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Office Hours:

Wednesday and Thursday: 11:30 AM – 12:30 PM or by appointment.

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Course Information

Course Format and Expectations

The course is organized as follows:

Lectures: 2 in-person lectures per week on Monday and Wednesday (10:30 AM - 11:20 AM).

Tutorials: 1 in-person tutorial per week on Thursday (10:30 AM - 11:20 AM).

Weekly quizzes.

Weekly assignments.

1 closed-book midterm test.

1 closed-book final exam.

Course Dates: 09/05/2023 - 12/06/2023

Units: 3.00

Course Delivery Mode: In Person

Course Description: Introduction to internal and external laminar and turbulent incompressible flows. Topics include turbulent boundary layers, aerodynamics and convective heat transfer. Three lectures; first term Prerequisite(s): MECHENG 3O04, CHEMENG 2O04, CHEMENG 3O04, or ENGPYS 3O04

Instructor-Specific Course Information

Avenue will be the hub for all official MECHENG 4S03 content.

Lectures will be delivered in person.

Lecture notes, quizzes, tutorials, and assignments & solutions will be posted on A2L.

Tutorials will be held in person. TAs will work through sample problems.

Teaching Assistants

- Ahmed Hassan (mohaa49@mcmaster.ca) - Ahmed will grade the odd numbered assignments and run the odd numbered tutorials.
- Mohamed Samy Hefny (hefnym1@mcmaster.ca) - Mohamed will grade the even numbered assignments and run the even numbered tutorials.

Course Topics

- Development of the Navier-Stokes equations
- Internal incompressible flows
- Laminar and turbulent boundary layers
- Lift and drag
- Airfoils
- Development of the energy equation
- Thermal boundary layers

Important Links

- [Mosaic](#)
- [Avenue to Learn](#)
- [Student Accessibility Services - Accommodations](#)
- [McMaster University Library](#)
- [eReserves](#)

Course Learning Outcomes

For accreditation reasons, these learning outcome statements must be tied back to CEAB graduate attributes (GAs), including those that are measured in this course. If you are unsure how to do this, please contact the Associate Chair Undergraduate in your department.

- Perform calculations on and describe the general properties of a convective derivative.
- Provide a physical explanation of the forces that are inherent in the Navier-Stokes equations.
- Simplify and solve the Navier-Stokes equations for simple internal incompressible flows.
- Describe the characteristics of laminar and turbulent boundary layers and derive the corresponding momentum integral equation.
- Calculate boundary layer characteristics such as local shear stress, total drag, and boundary layer thickness.
- Describe the requirements for flow separation and explain the impact of streamlining.
- Calculate the lift and drag forces on objects.

- Develop the thermal energy equation from first principles and explain what each term physically represents.
- Describe the basis of the heat and momentum transfer analogy and perform heat transfer calculations on thermal boundary layers.

Required Materials and Texts

Textbook Listing: <https://textbooks.mcmaster.ca>

Introduction to Fluid Mechanics

Authors: R. W. Fox, A. T. McDonald, and J. W. Mitchell

Publisher: John Wiley

Publication Date: 2020

Edition: 10th

Class Format

In Person

Course Evaluation

Grading Scheme: The following distribution of marks will be used unless there is a valid and compelling reason to use an alternative weighting. Missed assignments and tests without legitimate and documented reason will have a grade of zero.

- Quizzes: 10%
- Assignments: 20%
- Midterm test: 25%
- Final exam: 45%

Course Evaluation Details

- Weekly quizzes will be on A2L: These will be multiple choice quizzes. The quiz should be completed by Tuesdays at 6:00 PM.
- Assignments: Problem sets are planned for roughly every week. Due on Thursdays at 6:00 PM.
- Midterm Test: There will be one midterm test of 2 hours duration. To be scheduled.
- Final examination: 2.5 hours in duration. The final exam will cover all lecture materials.

Note that only the **McMaster Standard Calculator (Casio fx-991 and Casio fx-991MS)** will be permitted in tests and examinations. This is available at the Campus store.

Grading Scale

Grade	Equivalent Grade Point	Equivalent Percentages
A+	12	90-100
A	11	85-89
A-	10	80-84
B+	9	77-79
B	8	73-76
B-	7	70-72
C+	6	67-69
C	5	63-66
C-	4	60-62
D+	3	57-59
D	2	53-56
D-	1	50-52
F	0	0-49

Course Schedule

Week 1: Convective derivative; conservation of mass.

Week 2: Derivation of mass and momentum equations, frictionless flow, and Bernoulli's equation.

Week 3: Introduction to internal flows; parallel plates, piston cylinder; thin film.

Week 4: Laminar pipe flow; head loss; k-factors, friction factor for laminar flow, introduction to turbulence, pumps.

Week 5: Discussion of pressure; boundary layer concepts; integral analysis of a boundary layer.

Midterm will be held on Week 5 (the week of October 16 - 20). To be scheduled.

Week 6: Integral analysis of a boundary layer; von Karman and Blasius profiles.

Week 7: Turbulent boundary layers.

Week 8: Flow around immersed bodies – including flow normal to a plate.

Week 9: Boundary layers with pressure gradient; streamlining; flow over objects.

Week 10: Airfoils.

Week 11: Derivation of the energy equation; non-dimensional analysis.

Week 12: Non-dimensional analysis; Thermal boundary layer.

Late Assignments

It is the students' responsibility to regularly check the course webpage (ex. Avenue to Learn) for updates and announcements.

Assignments submitted after the stated deadline will face a 10 percent per-day late penalty (weekends and holidays included). The submission link on A2L will not accept assignment submissions later than 3 days (weekends and holidays included).

The weight of any missed work that has been properly reported and approved using MSAF will be automatically added to the weight of the final examination. No other

accommodation will be provided for missed work.

Absences, Missed Work, Illness

In the event of an absence for medical or other reasons, students should review and follow the Academic Regulation in the Undergraduate Calendar “Requests for Relief for Missed Academic Term Work”.

1. Relief for missed academic work worth less than 25% of the final grade resulting from medical or personal situations lasting up to three calendar days:

- Use the McMaster Student Absence Form (MSAF) on-line self-reporting tool. No further documentation is required.
- Students may submit requests for relief using the MSAF once per term.
- An automated email will be sent to the course instructor, who will determine the appropriate relief. Students must immediately follow up with their instructors. Failure to do so may negate the opportunity for relief.
- The MSAF cannot be used to meet a religious obligation or to celebrate an important religious holiday.
- The MSAF cannot be used for academic work that has already been completed or attempted.
- An MSAF applies only to work that is due within the period for which the MSAF applies, i.e. the 3-day period that is specified in the MSAF; however, all work due in that period can be covered by one MSAF.
- The MSAF cannot be used to apply for relief for any final examination or its equivalent. See Petitions for Special Consideration above.

2. For medical or personal situations lasting more than three calendar days, and/or for missed academic work worth 25% or more of the final grade, and/or for any request for relief in a term where the MSAF has been used previously in that term:

- Students must report to their Faculty Office to discuss their situation and will be required to provide appropriate supporting documentation.
- If warranted, the Faculty Office will approve the absence, and the instructor will determine appropriate relief

Turnitin.com

Some courses may use a web-based service (Turnitin.com) to reveal authenticity and ownership of student submitted work. For courses using such software, students will be expected to submit their work electronically either directly to Turnitin.com or via an online learning platform (e.g. A2L, etc.) using plagiarism detection (a service supported by Turnitin.com) so it can be checked for academic dishonesty.

Students who do not wish their work to be submitted through the plagiarism detection software must inform the Instructor before the assignment is due. No penalty will be assigned to a student who does not submit work to the plagiarism detection software. All submitted work is subject to normal verification that standards of academic integrity have been upheld (e.g., on-line search, other software, etc.). For more details about McMaster's use of Turnitin.com please go to www.mcmaster.ca/academicintegrity.

Generative AI: Use Prohibited

Students are not permitted to use generative AI in this course. In alignment with [McMaster academic integrity policy](#), it “shall be an offence knowingly to ... submit academic work for assessment that was purchased or acquired from another source”. This includes work created by generative AI tools. Also state in the policy is the following, “Contract Cheating is the act of “outsourcing of student work to third parties” (Lancaster & Clarke, 2016, p. 639) with or without payment.” Using Generative AI tools is a form of contract cheating. Charges of academic dishonesty will be brought forward to the Office of Academic Integrity.

APPROVED ADVISORY STATEMENTS

Academic Integrity

You are expected to exhibit honesty and use ethical behaviour in all aspects of the learning process. Academic credentials you earn are rooted in principles of honesty and academic integrity. **It is your responsibility to understand what constitutes academic dishonesty.**

Academic dishonesty is to knowingly act or fail to act in a way that results or could result in unearned academic credit or advantage. This behaviour can result in serious consequences, e.g. the grade of zero on an assignment, loss of credit with a notation on the transcript (notation reads: "Grade of F assigned for academic dishonesty"), and/or suspension or expulsion from the university. For information on the various types of academic dishonesty please refer to the [Academic Integrity Policy](https://secretariat.mcmaster.ca/university-policies-proceduresguidelines/), located at <https://secretariat.mcmaster.ca/university-policies-proceduresguidelines/>

The following illustrates only three forms of academic dishonesty:

- plagiarism, e.g. the submission of work that is not one's own or for which other credit has been obtained.
- improper collaboration in group work.
- copying or using unauthorized aids in tests and examinations.

Authenticity / Plagiarism

Some courses may use a web-based service (Turnitin.com) to reveal authenticity and ownership of student submitted work. For courses using such software, students will be expected to submit their work electronically either directly to Turnitin.com or via an online learning platform (e.g. Avenue to Learn, etc.) using plagiarism detection (a service supported by Turnitin.com) so it can be checked for academic dishonesty.

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Courses with an On-line Element

Some courses may use on-line elements (e.g. e-mail, Avenue to Learn, LearnLink, web pages, capa, Moodle, ThinkingCap, etc.). Students should be aware that, when they

access the electronic components of a course using these elements, private information such as first and last names, user names for the McMaster e-mail accounts, and program affiliation may become apparent to all other students in the same course. The available information is dependent on the technology used. Continuation in a course that uses on-line elements will be deemed consent to this disclosure. If you have any questions or concerns about such disclosure please discuss this with the course instructor.

Online Proctoring

Some courses may use online proctoring software for tests and exams. This software may require students to turn on their video camera, present identification, monitor and record their computer activities, and/or lock/restrict their browser or other applications/software during tests or exams. This software may be required to be installed before the test/exam begins.

Conduct Expectations

As a McMaster student, you have the right to experience, and the responsibility to demonstrate, respectful and dignified interactions within all of our living, learning and working communities. These expectations are described in the [Code of Student Rights & Responsibilities](#) (the “Code”). All students share the responsibility of maintaining a positive environment for the academic and personal growth of all McMaster community members, **whether in person or online.**

It is essential that students be mindful of their interactions online, as the Code remains in effect in virtual learning environments. The Code applies to any interactions that adversely affect, disrupt, or interfere with reasonable participation in University activities. Student disruptions or behaviours that interfere with university functions on online platforms (e.g. use of Avenue 2 Learn, WebEx or Zoom for delivery), will be taken very seriously and will be investigated. Outcomes may include restriction or removal of the involved students’ access to these platforms.

Academic Accommodation of Students with Disabilities

Students with disabilities who require academic accommodation must contact [Student Accessibility Services](#) (SAS) at 905-525-9140 ext. 28652 or sas@mcmaster.ca to make arrangements with a Program Coordinator. For further information, consult McMaster University's [Academic Accommodation of Students with Disabilities](#) policy.

Academic Advising

For any academic inquires please reach out to the Office of the Associate Dean (Academic) in Engineering located in JHE-Hatch 301.

Details on academic supports and contact information are available from:

<https://www.eng.mcmaster.ca/programs/academic-advising>

Requests for Relief for Missed Academic Term Work

In the event of an absence for medical or other reasons, students should review and follow the [Policy on Requests for Relief for Missed Academic Term Work](#).

Academic Accommodation for Religious, Indigenous, or Spiritual Observances (RISO)

Students requiring academic accommodation based on religious, indigenous or spiritual observances should follow the procedures set out in the [RISO](#) policy. Students should submit their request to their Faculty Office ***normally within 10 working days*** of the beginning of term in which they anticipate a need for accommodation or to the Registrar's Office prior to their examinations. Students should also contact their instructors as soon as possible to make alternative arrangements for classes, assignments, and tests.

Copyright and Recording

Students are advised that lectures, demonstrations, performances, and any other course material provided by an instructor include copyright protected works. The Copyright Act and copyright law protect every original literary, dramatic, musical and artistic work, **including lectures** by University instructors.

The recording of lectures, tutorials, or other methods of instruction may occur during a course. Recording may be done by either the instructor for the purpose of authorized distribution, or by a student for the purpose of personal study. Students should be aware that their voice and/or image may be recorded by others during the class. Please speak with the instructor if this is a concern for you.

Extreme Circumstances

The University reserves the right to change the dates and deadlines for any or all courses in extreme circumstances (e.g., severe weather, labour disruptions, etc.). Changes will be communicated through regular McMaster communication channels, such as McMaster Daily News, Avenue to Learn and/or McMaster email.