

ME3004 - Fluid Mechanics  
Fall 2022

Course Outline

CALENDAR/COURSE DESCRIPTION

This course is an introduction to the subject of fluid mechanics. It includes the following topics: fundamental concepts, fluid statics, conservation laws, incompressible inviscid flows, dimensional and similarity analysis, internal incompressible viscous flows, introduction to boundary layers, and lift and drag. While covering the basics and fundamentals of fluid mechanics, the emphasis in this course will be on using those basic principles to analyze various engineering systems.

COURSE TOPICS

- |   |  |
|---|--|
| 1. Introduction and Fundamental Concepts. | 5. Incompressible Inviscid Flow.         |
| 2. Fluid Statics.                         | 6. Dimensional Analysis.                 |
| 3. Integral Analysis.                     | 7. Internal Incompressible Viscous Flow. |
| 4. Differential Analysis.                 | 8. External Incompressible Viscous Flow. |

PRE-REQUISITES AND ANTI-REQUISITES

Prerequisite(s): Both MATH 2M03 and 2MM3 (or 2M06), or both MATH 2Z03 and 2ZZ3, or both MATH 2P04 and 2Q04; and registration in any Mechanical Engineering program.

INSTRUCTOR OFFICE HOURS AND CONTACT INFORMATION

Dr. M. Hamed  
Office: JHE 203  
Email: [hamedm@mcmaster.ca](mailto:hamedm@mcmaster.ca)

Office Hours:  
by appointment, upon request via email

Tel: 905-525-9140 Ext. 26113

TEACHING ASSISTANT OFFICE HOURS AND CONTACT INFORMATION

Name	Remon Basily	Abdelrahman Abdelrazek	Ethan Sun	Mohamed Hassan	Fiona Madden
Email	<a href="mailto:basilyr@mcmaster.ca">basilyr@mcmaster.ca</a>	<a href="mailto:abdela86@mcmaster.ca">abdela86@mcmaster.ca</a>	<a href="mailto:suny103@mcmaster.ca">suny103@mcmaster.ca</a>	<a href="mailto:safymosm@mcmaster.ca">safymosm@mcmaster.ca</a>	TBA
Office Hour	TBA	TBA	TBA	TBA	TBA
Location	TBA	TBA	TBA	TBA	TBA
Tutorial Section	TBA	TBA	TBA	TBA	TBA

COURSE WEBSITE/ALTERNATE METHODS OF COMMUNICATION

<http://avenue.mcmaster.ca/>

**COURSE INTENDED LEARNING OUTCOMES**

By the end of this course, students should be able to:

1. Understand and use force analysis in static and moving fluids to analyze fluid flow systems.
2. Understands and knows how to apply the various methods of analysis in fluid mechanics (the Reynolds Transport Equation -Control Volume Analysis and differential approach) to solve real-life fluid flow problems.
3. Select and use flow visualization tools (e.g., Timelines, Streamlines, Pathlines, and Streaklines) to analyze and understand the main features of a certain fluid flow.
4. Comprehends the concepts of boundary layer, displacement thickness, and flow separation and be able to use these concepts to simplify the analysis of real flows.
5. Understand the concept of similarity and dimensional analysis and be able to use it to develop and carry out model-prototype analysis.
6. Estimate friction loss in fluid flow networks.

**MATERIALS**

**Required Textbook:**

"Introduction to Fluid Mechanics", by R. W. Fox, A. T. McDonalds, and J. W. Mitchell, 9th edition, John Wiley, 2015.

- The textbook will be used to assign problems.
- It supplements lectures and class discussions. However, it is not a substitute for lectures.

**Calculator:** Only a Casio FX-991 MS or MS+ calculator is allowed.

**Other Materials:** A number of illustrative videos will be used during lectures.

**COURSE FORMAT AND EXPECTATIONS**

- The course is organized as follows:
  - 3 classroom-based lectures per week,
  - 1 classroom-based tutorial per week
  - 2 closed-book, in-class, term tests
  - Closed-book, bi-weekly quizzes.
  - A closed-book, in-class, final exam. The final exam covers all course material.
  - The two term tests and the final exam will include questions on theory and concepts covered during class discussions and tutorials.

**ASSESSMENT**

Component	Date/Time	Weight
Quizzes	Bi-weekly	10%
Term test 1	Thursday Oct 6 <sup>th</sup> at 7:30-9:00 PM	20%
Term test 2	Thursday Nov 10 <sup>th</sup> at 7:30-9:00 PM	20%
Final Exam	TBA	50%
Total		100%

## LECTURES

- Lecture notes will be posted on A2L.
- All posted material is copyright protected and should not be shared with and/or distributed to others.
- In-class lectures will be delivered on Mondays/Thursdays at 12:30-1:20 PM EST and on Tuesdays at 1:30-2:20 PM EST, all lectures are in JHE-264.
- Class discussions might cover points that are not necessarily included in the textbook.
- All exams (i.e., term tests and final) will include questions on concepts covered during class discussions.
- Therefore, attending lectures is very important and highly recommended.

## TUTORIALS

1. In-class tutorials will start the week of September 12<sup>th</sup>.
2. Tutorials for T01 are on Thursdays at 4:30-6:20 PM EST in CNH B107.
3. Tutorials for T02 are on Fridays at 8:30-10:20 AM EST in ABB 102.
4. A set of **Additional Problems**, like the assigned ones, will be posted on A2L.
5. The TAs will solve these “Additional Problems” during the tutorials.
6. The TAs will also address any unclear concepts and/or help students to solve the assigned problems.

## QUIZZES

1. To encourage students to attend tutorials and to study regularly, quizzes will be administered roughly every two weeks.
2. Quizzes will be provided in-class during the tutorials
3. Some quizzes might be provided on online using A2L.
4. Quizzes will cover conceptual and/or calculation problems like the assigned and the additional problems.
5. A timetable and clear guidelines regarding the quizzes will be provided on A2L.

## ASSIGNMENTS

- Roughly, every week, textbook problems and conceptual questions based on class discussions will be assigned and posted on A2L.
- Students are strongly encouraged to attempt solving these assignments to prepare for the term tests and the final examination.
- Students' assignment solutions ***will not be*** collected or marked.
- Solutions of the **Assigned** and the **Additional Problems** will be posted on A2L before each term test and before the final exam.

#### EQUATIONS NEEDED FOR TERM TESTS AND FINAL EXAM

- Formulas are included in an “**Equations Sheet**” that will be posted on A2L.
- Only formulas provided on the posted “Equations Sheet” will be included in the two term test papers and the final examination paper.
- All other formulas that have been covered in class and/or included in the course material; however not included within the posted “Equations Sheet”, **will not be** included in the term tests paper or the final exam paper. Students are expected to study and memorize such formulas.

#### ACCREDITATION LEARNING OUTCOMES

The Learning Outcomes defined in this section are measured for Accreditation purposes only and will not be directly taken into consideration in determining a student’s grade in the course.

Outcomes

Indicators

1-6

Knowledge base for Engineering

For more information on Accreditation, please visit: <https://www.engineerscanada.ca>

#### EQUITY, DIVERSITY, AND INCLUSION

Every registered student belongs in this course. Diversity of backgrounds and experiences is expected and welcome. You can expect your Instructor to be respectful of this diversity in all aspects of the course, and the same is expected of you.

The Department of Mechanical Engineering is committed to creating an environment in which students of all genders, cultures, ethnicities, races, sexual orientations, abilities, and socioeconomic backgrounds have equal access to education and are welcomed and treated fairly. If you have any concerns regarding inclusion in our Department, in particular if you or one of your peers is experiencing harassment or discrimination, you are encouraged to contact the Chair, Associate Undergraduate Chair, Academic Advisor or to contact the [Equity and Inclusion Office](#).

#### PHYSICAL AND MENTAL HEALTH

For a list of McMaster University’s resources, please refer to the [Student Wellness Centre](#).

#### 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](#), located at <https://secretariat.mcmaster.ca/university-policies-procedures-guidelines/>

The following illustrates only three forms of academic dishonesty:

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

#### 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 A2L, 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](mailto:sas@mcmaster.ca) to make arrangements with a Program Coordinator. For further information, consult McMaster University's [Academic Accommodation of Students with Disabilities](#) policy.

#### COURSE POLICY ON MISSED WORK, EXTENSIONS, AND LATE PENALTIES

1. It is the students' responsibility to regularly check the course webpage on A2L for updates and announcements.
2. Any legitimate conflicts with the two term tests scheduled on **Oct 6<sup>th</sup> and Nov 10<sup>th</sup>** (at 7:30-9:00 PM EST) must be communicated by email to Dr. Hamed at the start of the term. The deadline to do so is **Friday Sept 23<sup>rd</sup>, 2022**. No accommodations will be provided for conflicts reported after this deadline.
3. 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.

#### SUBMISSION OF REQUEST FOR RELIEF FOR MISSED ACADEMIC WORK

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 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.

*In ME3004, 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.*

#### 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, A2L and/or McMaster email.

# STUDENT SUPPORTS

## WELLNESS

### Student Wellness Centre

On-Campus Support for Medical and Mental Health Concerns. Doctors and Counsellors available. Located in PGCL, 2nd Floor.

**Mon-Fri 9AM-5PM 905-525-9140 ext. 27700**  
<https://wellness.mcmaster.ca/contact-us/>

### Main St. West Urgent Care Centre

For immediate health concerns that do not require the emergency room.

**690 Main St W - Mon-Sun 9AM-9PM**

### Emergency Rooms

For **immediate, serious** health concerns.

**St. Joseph's Healthcare Hamilton**  
50 Charlton Ave E

**McMaster Children's Hospital**  
Students 17 and under

### Telehealth Ontario

Telehealth Ontario is a free, confidential service you can call to get health advice or information. A Registered Nurse will take your call 24 hours a day, seven days a week.

**Toll-free: 1-866-797-0000 Toll-free TTY: 1-866-797-0007**

### Phone Lines

#### Good2Talk

Confidential helpline providing professional counselling, info and referrals for mental health, addiction, and well-being

**1-866-925-5454**

#### LGBT Youthline

Confidential, non-judgemental & informed LGBTQQ2SI peer support.

**Sun-Fri, 4-9:30 PM, Text 647-694-4275**

#### SACHA (SEXUAL ASSAULT CENTRE - HAMILTON AREA)

Confidential, anonymous 24-hour nonjudgmental telephone support for adults who have experienced sexual violence at any point in their lives; will provide accompaniment to hospital or police station for survivors wishing to seek medical attention or report; counselling services & public education

**905-525-4162**

#### Empower Me (Graduate Students)

24/7 accessible counselling services to empower you to thrive, crisis support, mental health and well-being services.

**1-844-741-6389**

#### Bounceback

CBT skills-building for mild to moderate depression and anxiety for people 15 or older. If accessed through self-referral, the client's primary care provider will be notified.

**1-866-345-0224**

## INDIGENOUS STUDENTS

### Indigenous Student Services

Academic & social counselling, employment aid  
LRW 1010

**ext. 23788**

**indigenous.admin@mcmaster.ca**  
**indigenous.mcmaster.ca**

## INTERNATIONAL STUDENTS

### International Student Services

Advising services for international students and exchange students  
GH 104

**ext. 24254**

**iss@mcmaster.ca**  
**iss.mcmaster.ca**

# STUDENT SUPPORTS

## ACADEMIC

### Student Success Centre

Academic skills assistance, job search, volunteering  
GH 110

ext. 24254  
[studentsuccess@mcmaster.ca](mailto:studentsuccess@mcmaster.ca)

### Student Accessibility Services

Disability services, assistive technology support  
MUSC B107

ext. 28652  
[sas@mcmaster.ca](mailto:sas@mcmaster.ca)

### TutorOcean

Student to Student Tutoring Services  
<https://mcmaster.tutorocean.com/>

## FINANCIAL

### Office of Student Financial aid and Scholarships

Emergency funding, government funds, OSAP assistance, scholarships, work programs  
GH 120

ext. 24319  
<https://registrar.mcmaster.ca/aid-awards/>

## FOOD

### Food Collective Centre (FKA Mac Bread Bin)

The Food Collective Centre is a service run by students dedicated to cultivating stronger food systems in the McMaster and surrounding community. (MSU Service)

[macbreadbin@msu.mcmaster.ca](mailto:macbreadbin@msu.mcmaster.ca)  
<https://www.msumcmaster.ca/services-directory/14-food-collective-centre>

### Neighbour 2 Neighbour

Food bank, community kitchen, community counselling, help with paying for utilities, and more. Hamilton Mountain.

905-574-1334 <http://www.n2ncentre.com/>

## CRISIS SUPPORT

### Barrett Centre for Crisis Support

Provides a safe environment in the community and responds to the needs of individuals, 16 years of age or older, who experience a mental health crisis and do not require a hospital stay. Confidential and free services 24/7/365

24 Hour Crisis Line: 905-529-7878, Toll Free: 1-844-777-3571

### COAST (Crisis Outreach and Support Team)

Hamilton's crisis line is answered 24 hours a day, 7 days a week. The COAST mobile team, consisting of a mental health worker, and a police officer, will respond to crisis calls between the hours of 8 a.m. and 1 a.m. daily.

905-972-8338

### Oakville Distress Centre

Distress Centre Halton provides telephone and online support to people to better cope with crisis, loneliness, and emotional stress. Also serves the Hamilton area.

905-849-4541

### Assaulted Women's Helpline

Free, anonymous and confidential telephone and TTY crisis telephone line to all women in the province of Ontario who have experienced any form of abuse. Provides crisis counselling, safety planning, emotional support, information and referrals accessible 24/7/365.

Toll-free: 1-866-863-0511 TTY: 1-866-863-7868

### Crisis Resources in the GTA

The CAMH Distress Crisis Resources web page lists a number of phone lines, response teams and hospitals in the GTA.

<https://www.camh.ca/en/health-info/crisis-resources>



# STUDENT SUPPORTS

## OTHER

### **Student Assistance Plan (Undergraduate)**

Psychological counseling (offered in-person, over the phone, or over secure video) and academic-life services (legal consultation, financial consultation, life coaching, nutrition consultation and wellness resources offered virtually or in-person)

<https://www.msumcmaster.ca/services-directory/36-health-and-dental-insurance/student-assistance-plan>

### **Ombuds Office**

Advice for students, staff, and faculty regarding academic and non-academic concerns.

MUSC 210

ext. 24151

[ombuds@mcmaster.ca](mailto:ombuds@mcmaster.ca)

[mcmaster.ca/ombuds](http://mcmaster.ca/ombuds)

### **SWHAT - Walk Safe Program**

The Student Walk Home Attendant Team (SWHAT) is a volunteer service within the McMaster Students Union that will walk or bus with students during the evening hours 7 days a week, in all kinds of weather! (MSU Service)

Ext. 27500

[swhat@msu.mcmaster.ca](mailto:swhat@msu.mcmaster.ca)

### **Student Support and Case Management**

Student rights & responsibilities

GH 207

ext. 23845

[studentconduct.mcmaster.ca](http://studentconduct.mcmaster.ca)

### **Chaplaincy Centre**

Pastoral support with personal counselling and bereavement support groups.

MUSC 231

ext. 24207

### **McMaster Engineering Society**

Support from other McMaster Engineering Students

<https://www.macengsociety.ca/>

## **MSU PEER SUPPORT SERVICES**

### **MSU Maccess**

Maccess is a service that aims to build and maintain a campus that celebrates, advocates, and ensures inclusivity in the area of disability. A central aspect to Maccess is the provision of peer support by trained volunteers with lived experiences with disability such as chronic illness, mental illness, mental health concerns, neurodivergence, and additional identities.

### **Student Health Education Centre**

SHEC is a peer-run health promotion, education, and referral service for McMaster University students. SHEC focuses on engaging with students about health-related issues through performances, peer support, fundraisers, and events. The service offers peer support, anonymous and confidential pregnancy testing, a resource library, condoms, lubricant, and menstrual products. SHEC's space is located in MUSC 202.

### **Women + Gender Equity Network**

WGEN is a service that caters to women, transfolk, people who identify outside the gender binary, and all survivors of sexual assault. WGEN provides a safe(r) space and resource library on campus in MUSC 204. Volunteers in the space offer peer support and the service also runs a support group for survivors of domestic and intimate partner violence.

### **Pride Community Centre**

The Pride Community Centre is a service of the McMaster Students Union. We provide a contact point for McMaster students that may identify as gay, lesbian, bisexual, transgender, queer, and/or any of the other diverse identities that make up our community. We offer educational programming and access to resources of interest, as well as peer support and a physical space for students to meet and socialize with each other. As advocates for gender & sexual diversity, the PCC's mandate upholds that LGBTQ+ students are entitled to a safe and supportive campus, absent of homophobia and transphobia, where the expression of one's gender & sexual identity is welcomed and respected.