# MIE504H1 – Applied Computational Fluid Dynamics- Syllabus

## Course Outline

**Instructor**
Prof. Ali Dolatabadi
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**Office Hour**
*Tuesdays: 1:00-2:00 pm*

**Teaching Assistants**
- *Tara Yazdanimotlagh* **(Head TA)**
tara.yazdanimotlagh@mail.utoronto.ca
*Office hour: Fridays: 11:00-12:00 (BA8256)*

- *Shaghayegh Tarab Khah*
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*Office hour: Mondays: 12:00-1:00 pm (BA8256)*

- *Farshad Tajeddini*
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**Course Schedule**
- Lectures:
  Tuesdays 3:00-6:00 pm MB 123

**Contact Hours**
- Lectures:
  3 hrs x 13 wks/term = 39 hrs

**Prerequisites**
MIE230, MAT234, MIE334

**Course Website**
https://q.utoronto.ca

## Important Dates

**Mid-term Exam**
Date: October 15, 3:00-6:00 pm
Location: MB 123

**Term projects due dates:**
Project 1: October 6, 11:59 PM
Project 2: November 10, 11:59 PM
Project 3: December 3, 11:59 PM

## Course Description

The course is designed for students with no or little Computational Fluid Dynamics (CFD) knowledge who want to learn CFD applications to solve engineering problems. Fundamental topics will be covered which will help students to properly use open source and commercial CFD packages. The course will provide a general perspective to the CFD and its application to fluid flow and heat transfer and it will teach the use of some of the popular CFD packages and provides them with the necessary tool to use CFD in specific applications.

The course structure is as follows:

- MIE 504 lectures (PowerPoint presentations) are available on the course website on Quercus.
- All term work will be submitted on-line. Term work will consist of 3 mini projects.
- Midterm and final exams will be open book.
- All student questions outside the lectures should be posted on the discussion panel on Quercus.
- For administrative issues communicate with the Head TA, Ms. Tara Yazdanimotlagh (tara.yazdanimotlagh@mail.utoronto.ca).

## Suggested Books and Online Resources

- D. Anderson, J. C. Tannehill, and R. H. Pletcher, Computational Fluid Mechanics and Heat Transfer, CRC Press, 2016
- C. Hirsch, Numerical Computation of Internal & External Flows: The Fundamentals of CFD, Elsevier, 2007
- B. Vermeir, C. Pereira, and H. Karbasian. Computational Fluid Dynamics: An Open Source Approach, 2020 (https://users.encs.concordia.ca/~bvermeir/books.html)
- F. Moukalled, L. Mangani, and M. Darwish, "The Finite Volume Method in Computational Fluid Dynamics", Springer 2016
- Ansys Fluent Guide
- Ansys User Portal: https://support.ansys.com/portal/site/AnsysCustomerPortal
- CFD Forum: http://www.cfd-online.com/

## List of Topics

The following modules and topics will be covered in this course:

- Conservation laws
- Discretization and proprieties of discretized equation (Consistency, Stability, Convergence)
- Numerical solution methods
- Applications in fluid flow and heat transfer

## Learning Objectives

By the end of this course, you will be able to:

- Understand the fundamentals of computational fluid dynamics as it applies to various thermofluids systems.
- Model 2D and 3D systems using proper discretization and solution schemes.
- Understand and explain the uncertainty and error analysis.
- Evaluate how different sub-models can be used to solve complex thermofluids problems.

## Accreditation Details

**Accreditation Units**
Mathematics: 20%
Natural Science: 0%
Complementary Studies: 0%
Engineering Science: 60%
Engineering Design: 20%

**Graduate Attributes**
GA1: Knowledge base for engineering
GA2: Problem analysis
GA3: Investigation
GA4: Design
GA5: Use of engineering tools
GA6: Individual and team work
GA7: Communication skills
GA8: Professionalism
GA9: Impact of engineering on society/environment
GA10: Ethics and equity
GA11: Economics and project management
GA12: Life-long learning

**Competency Levels**
1 – Knowledge (Able to recall information)
2 – Comprehension (Ability to rephrase information)
3 – Application (Ability to apply knowledge in a new situation)
4 – Analysis (Able to break problem into its components and establish relationships)
5 – Synthesis (Able to combine separate elements into a whole)
6 – Evaluation (Able to judge the worth of something)

## Expected Competency Levels

| Objective | GA1 | GA2 | GA3 | GA4 | GA5 | GA6 | GA7 | GA8 | GA9 | GA10 | GA11 | GA12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 6 | 6 | | | | | | | | | | |
| 2 | 6 | 6 | | 6 | | | | | | | | |
| 3 | | | 6 | | 6 | | 6 | | | 3 | | |
| 4 | 6 | 6 | | | | | 6 | 6 | | 3 | | |

## Evaluation

Below is the mark composition. It should be noted that graduate students will be graded the same as undergraduate students and will require 70% or better to pass.

| Component | Value (%) | Method of Feedback | Learning Objectives Evaluated |
|---|---|---|---|
| Term project 1 | 10 | Online Commented Document | GA1,2,3,4,5,7,8,10 |
| Term project 2 | 15 | Online Commented Document | GA1,2,3,4,5,7,8,10 |
| Term project 3 | 15 | Online Commented Document | GA1,2,3,4,5,7,8,10 |
| Midterm exam | 20 | Online Commented Document | GA1,2,3,4,5,7,8,10 |
| Final exam | 40 | | GA1,2,3,4,5,7,8,10 |

## Course Schedule

| Week | Subject |
|---|---|
| Week 1 | Course intro + Governing equations |
| Week 2 | Review numerical methods |
| Week 3 | Discretization + Consistency, Stability, Convergence |
| Week 4 | Solution methods/solvers |
| Week 5 | Finite volume method for diffusion and convection-diffusion problems |
| Week 6 | Geometry and mesh generation |
| Week 7 | Boundary and initial conditions |
| Week 8 | Flow classifications |
| Week 9 | Heat transfer |
| Week 10 | Turbulence modeling |
| Week 11 | Turbulence modeling |

| | |
|---|---|
| Week 12 | Advanced topics |

## Online Help

Students are expected and encouraged to actively participate in the lecture sessions by asking and answering questions. All student questions outside the lectures should be first communicated with the Head TA, Ms. Tara Yazdanimotlagh (tara.yazdanimotlagh@mail.utoronto.ca) or posted on the Discussion tab on Quercus. She will respond and may repost the content of the exchange on Quercus so that everyone can see the question and response.

## Academic Integrity

Students are expected to conduct themselves in accordance with the highest ethical standards of the Profession of Engineering and evince academic integrity in all their pursuits and activities at the university. As such, in accordance with the General Academic Regulations on Academic Integrity, students are reminded that plagiarism or any other form of cheating in examinations, assignments, projects, or reports is subject to serious academic penalty (e.g. suspension or expulsion from the faculty or university). A student found guilty of contributing to cheating by another student is also subject to serious academic penalty.

## Mental Health and Wellness

As a university student, you may experience a range of health and/or mental health issues that may result in significant barriers to achieving your personal and academic goals. The University of Toronto offers a wide range of free and confidential services and programs that may be able to assist you. We encourage you to seek out these resources early and often.

- Student Life Website: http://www.studentlife.utoronto.ca
- Health and Wellness Website: http://studentlife.utoronto.ca/hwc

If, at some point during the year, you find yourself feeling distressed and in need of more immediate support, visit the **Feeling Distressed Webpage**:

http://www.studentlife.utoronto.ca/feeling-distressed, for more campus resources.

Off campus, immediate help is available 24/7 through **Good2Talk**, a post-secondary student helpline at 1-866-925-5454.

All students in the Faculty of Engineering have an Academic Advisor who can advise on academic and personal matters. You can find your department's Academic Advisor here:

http://undergrad.engineering.utoronto.ca/advising-support-services/academic-advising/

## Inclusivity Statement

Students, staff and faculty of MIE 504 represent a diverse community in which mutual respect is a foremost principle. This means that no matter a person's gender, race, religion, sexual identity, language or background they will be included as equals, their ideas will be listened to and considered and they will be given all opportunity to participate and contribute to the creation of knowledge that is the goal of this course.

## Acknowledgment of Traditional Land

We wish to acknowledge this land on which the University of Toronto operates. For thousands of years it has been the traditional land of the Huron-Wendat, the Seneca, and most recently, the Mississaugas of the Credit River. Today, this meeting place is still the home to many Indigenous people from across Turtle Island and we are grateful to have the opportunity to work on this land.