EP 3O04
Introduction to Fluid Mechanics and Heat Transfer

Undergraduate Studies
Winter 2024
Course Outline

CALENDAR/COURSE DESCRIPTION

This course will introduce the fundamental of fluid mechanics and heat transfer phenomena. The topics include:

1- Properties of Fluids
2- Fluid Statics, Buoyancy, and Stability
3- Bernoulli and Energy Equations
4- Internal Flow
5- External Flow
6- Mechanisms of Heat Transfer
7- Steady Heat Conduction
8- Transient Heat Conduction
9- Forced Convection
10- Heat Exchangers

PRE-REQUISITES AND ANTI-REQUISITES

Prerequisite(s): MATH 2Z03 and credit or registration in MATH 2ZZ3

INSTRUCTOR OFFICE HOURS AND CONTACT INFORMATION

Dr. Ali Shams

shamsa6@mcmaster.ca

Office Hours:

by appointment

TEACHING ASSISTANT OFFICE HOURS AND CONTACT INFORMATION

1- Brenda Cruz Razgado

cruzrazb@mcmaster.ca

Office Hours:

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2- Catherine Boyetey

boyeteyc@mcmaster.ca

Office Hours:

by appointment

LAB CO-ORDINATOR CONTACT INFORMATION

Dr. Matthew Moran

moranm@mcmaster.ca

COURSE WEBSITE/ALTERNATE METHODS OF COMMUNICATION

The primary method of communication will be:

1- Avenue To Learn (ATL, http://avenue.mcmaster.ca/) news postings for announcements (make sure to set your ATL email settings so it emails these to you.)

2- Email for individual messages.

COURSE INTENDED LEARNING OUTCOMES

By the end of this course, students should be able to understand and solve the problems involving:

- Fluid properties and fluid static calculations;
- Basic conservation equations of continuity, energy, and momentum for internal and external flows;
- Laminar and turbulent fluid flows, pressure drop in a pipe or/and duct, and pipe network analysis using modified Bernoulli's equation;
- Fluid machinery and measuring devices
- The general conduction, convection, and radiation heat transfer;
- Steady and transient conduction, forced convection, and mixed conduction-convection heat transfer; and
- Heat exchangers and calculation methodology.

MATERIALS AND FEES

Required Texts:

"Fundamental of Thermal-Fluid Sciences" by Çengel, Cimbala, and Turner, 4th edition or newer – (note this is the same textbook that was used in EP 2NE3)
This textbook is MANDATORY and required for all assignments and the final test.

Recommended Additional Texts:
Course notes/slides provided by the instructor.

Calculator:
Only the McMaster Standard Calculator will be permitted in tests and examinations. This is available at the Campus Store.

Computer:
Students should have a laptop or Desktop capable of running fluid flow simulation software (i.e. ANSYS FLUENT) and MS Office package.

Software:
MS Word (2007 or newer)
ZOOM (current version)
ANSYS (current student version – the details will be discussed in the first week of the semester)

COURSE FORMAT AND EXPECTATIONS

The course is organized as follows:

- 3 lectures per week: Monday, Wednesday, and Thursday, 1:30 pm – 2:20 pm.
- 1 tutorial per week: Monday, 5:30 pm – 6:20 pm. The assignment problems are solved and discussed within the tutorial time slot by the TA.
- 1 lab session every other week during the lab period. The lab session starts from the 2nd week of the semester.

COURSE SCHEDULE

Week	Topic	Readings
Week 1	- No-Slip - Flow Classification - Vapor Pressure and Cavitation - Viscosity, Surface Tension, and Capillary Effect - Fluid Statics, Buoyancy, and Stability	Chapter 10 (10-1 to 10-5) Chapter 11 (11-1 to 11-4)
Week 2	- The Bernoulli Equation - The Energy Equation	Chapter 12 (12-1 to 12-2)
Week 3	- Internal Flows - Laminar and Turbulent Flows - The Entrance Region - Laminar Flows in Pipe	Chapter 14 (14-1 to 14-4)
Week 4	- Turbulent Flows in Pipes - Major and Minor Losses - Piping Networks and Pump Selection	Chapter 14 (14-5 to 14-7)
Week 5	- External Flows - Drag and Lift - Friction and Pressure Drag, Flow Separation - Drag Coefficient of Common Geometries - Parallel Flow Over a Plate - Flow Over Cylinders and Spheres - Lift	Chapter 15 (15-1 to 15-7)
Week 6	- Conduction - Convection - Radiation - Simultaneous Heat Transfer Mechanisms - Steady Heat Conduction in Plane Walls - Thermal Contact Resistance Generalized Thermal Resistance Networks	Chapter 16 (16-1 to 16-5) Chapter 17 (17-1 – 17-3)
Week 7	**Midterm Recess**	**N/A**

Week 8	- Heat Conduction in Cylinders and Spheres - Critical Radius of Insulation - Heat Transfer from Finned Surface	Chapter 17 (17-4 to 17-6)
Week 9	- Lumped System Analysis - Transient Heat Conduction in Different Bodies - Transient Heat Conduction in Semi-Infinite Solids - Transient Heat Conduction in Multidimensional Systems	Chapter 18 (18-1 to 18-4)
Week 10	- Physical Mechanisms of Convection - Thermal Boundary Layer - Parallel Flow Over Flat Plates - Flow Across Cylinders and Spheres	Chapter 19 (19-1 to 19-4)
Week 11	- General Considerations for Pipe Flow (Convection) - General Thermal Analysis - Laminar and Turbulent Flows in Tubes (Convection)	Chapter 19 (19-5 to 19-8)
Week 12	- Types of Heat Exchangers - The Overall Heat Transfer Coefficient - Analysis of Heat Exchangers - The Log Mean Temperature Difference Method - The Effectiveness – NTU Method	Chapter 22 (22-1 to 22-5)
Week 13	Review and Problem Solving (Fluid Mechanics)	Chapter 10, 11, 12, 14, 15
Week 14	Review and Problem Solving (Heat Transfer)	Chapter 16, 17, 18, 19, 22

ASSESSMENT

Component	Weight
Experimental Lab Reports	30% (7% each + 2% Orientation)
Assignments	40% (5% each)
Final Exam	30%
Lecture Quizzes	***BONUS (up to 5%)***
Research Project (CFD)	***SPECIAL BONUS (up to 10%)***
Total	100%

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 Engineering Physics 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.

AUTHENTICITY / PLAGIARISM DETECTION

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.

COURSES WITH AN ON-LINE ELEMENT

McMaster is committed to an inclusive and respectful community. These principles and expectations extend to online activities including electronic chat groups, video calls and other learning platforms.

Some courses may use on-line elements (e.g. e-mail, Avenue to Learn (A2L), 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.

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.

COURSE POLICY ON MISSED WORK, EXTENSIONS, AND LATE PENALTIES

1. It is the students' responsibility to regularly check the course webpage (ex. Avenue to Learn) for updates and announcements.
2. Work (such as lab reports and assignments) submitted less than 24 hours after a deadline will receive a 50% late penalty. Work submitted more than 24 hours after the deadline will receive a mark of ZERO.
3. There are no makeups for the assignments and tests missed or extension of deadlines for assignments and lab reports; thus, failure to attend a test will result in receiving a grad of ZERO for the evaluation. Missed assignments marks will be pro-rated based on the other assignments and final exam only if legitimate reason supported by official documentation (MSAF) is provided within 3 business days of the date of the evaluation.
4. All questions related to marking, marking schemes, and assigned marks should be provided by email to the course instructor within 1 week of receiving the grade. Included in the email should be an image of work which was incorrectly marked, an image showing the correct solution, and a description of what the issue was in the marking. No grade change requests will be processed without this documentation.

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.

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.