

EP 3004
Introduction to Fluid Mechanics and Heat Transfer
Fall 2016
Course Outline

CALENDAR/COURSE DESCRIPTION

This course will introduce the fundamentals of fluid mechanics and heat transfer phenomena. The principle objectives of the course are to provide an engineering knowledge of:

1. Fluid properties and fluid static calculations;
2. Basic conservation equations of continuity, energy and momentum for internal and external flows;
3. Fluid flow, pressure drop, and pipe network analysis using the modified Bernoulli equation;
4. Fluid machinery and measuring devices;
5. Conduction, convection and radiation heat transfer;
6. Mixed conduction and convection problems, transients
7. Heat exchangers and calculation methodology

PRE-REQUISITES AND ANTI-REQUISITES

Prerequisite(s): Registration in Level III or above of any Engineering Physics program; credit or registration in MATH 2M06 (or 2M03 and 2MM3); or MATH 2P04 and 2Q04; or [MATH 2Z03](#) and [MATH 2Z23](#)

Antirequisite(s): ENG PHYS 3003

INSTRUCTOR & LAB TECHNICIAN OFFICE AND CONTACT INFORMATION

Instructor: Dr. M.D. Minnick
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Lab Technician: Dan FitzGreen
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TEACHING ASSISTANT CONTACT INFORMATION

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COURSE WEBSITE/ALTERNATE METHODS OF COMMUNICATION

<http://engphys.mcmaster.ca/undergrad-studies/ug-courses/eng-phys-3o04/>

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 OBJECTIVES

Fluid properties and statics are introduced. Basic equations of continuity, energy and momentum for internal and external flows are discussed. Similitude, dimensional analysis, measuring devices, fluid machinery and hydraulic networks. Conduction and convection heat transfer.

MATERIALS AND FEES

Required Texts:

"Fundamentals of Thermal-Fluid Sciences" by Cengel, Cimbala and Turner, 4th edition or newer – note this is the same text that was used in EP 2NE3. **This textbook is mandatory and required for ALL quizzes.**

Calculator:

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

Other Materials:

None.

ASSESSMENT

Component	Weight
Experimental Lab Reports	15%
Tutorial Quizzes	55% (5% each)
CFD Design Project	Special Bonus
Lecture Quizzes	Bonus 2%
Final Exam	30%
Total	100%

See ATL for information on the Design Project.

COURSE SCHEDULE		
Date	Lecture Topic	Tutorial Topic
Tue 6 Sep	Intro, 10-1 to 10-3: Flow Intro, Vapor Pressure & Cavitation	
Wed 7 Sep	10-4 & 10-5: Viscosity, Surface Tension & Capillary Effect	No Tutorial
Fri 9 Sep	11-1 to 11-4: Fluid Statics	
Tue 13 Sep	Review Day: Ch 10 & 11	
Wed 14 Sep	12-1: Bernoulli Equation	Ch10&11
Fri 16 Sep	12-2 & 3: The Energy Equation	
Tue 20 Sep	Review Day: Ch 12	
Wed 21 Sep	14-1 to 14-4 Internal Flows, Laminar & Turbulent, Entrance Region, Laminar Detailed	Ch12
Fri 23 Sep	14-5: Turbulent Detailed	
Tue 27 Sep	Review	
Wed 28 Sep	14-6: Minor Losses,	Ch14-1 to 14-5
Fri 30 Sep	14-7: Piping networks & Pump Selection	
Tue 4 Oct	Review	
Wed 5 Oct	15-1 to 15-4: Drag & Lift Intro, Drag via coefficients	Ch14-6&7
Fri 7 Oct	15-5 to 15-7: Flat plate drag, Cylinder & sphere drag, Lift	
Tue 11 Oct	Midterm Recess	
Wed 12 Oct	Midterm Recess	
Fri 14 Oct	Midterm Recess	
Tue 18 Oct	Review	
Wed 19 Oct	16: Intro to heat transfer	Ch15
Fri 21 Oct	17.1-17.3: Steady Heat Conduction, Thermal Resistance	
Tue 25 Oct	Review	
Wed 26 Oct	17.4-17.5: Heat Conduction in Cylinders & Spheres, CIR	Ch16 & 17-1 to 17-3
Fri 28 Oct	17.6: Fins	
Tue 1 Nov	Review	
Wed 2 Nov	18-1 & 2: Lumped System Analysis & 1d Transient Conduction	Ch17-4 to 17-6
Fri 4 Nov	18-3 & 4: Semi-Infinite Solids & Multidimensional Extension	
Tue 8 Nov	Review	
Wed 9 Nov	19.1-3: Convection, Thermal Boundary Layer, Flat Plates	Ch18
Fri 11 Nov	19.4: Convection in Flow Across Cylinders & Spheres	
Tue 15 Nov	Review	
Wed 16 Nov	19.5-6: Convection in Pipe flow & General Thermal Analysis	Ch19-1 to 19-4
Fri 18 Nov	19.7-8: Convection from Laminar & Turbulent Flow in Tubes	
Tue 22 Nov	Review	
Wed 23 Nov	22.1-22.4: Heat Exchanger Intro & LMTD Analysis	Ch19-5 to 19-8
Fri 25 Nov	22.5: Effectiveness-NTU Analysis of Heat Exchangers	
Tue 29 Nov	Review	
Wed 30 Nov	FYI: Course in Retrospect, and the need for CFD	Ch22
Fri 2 Dec	FYI: Microfluidics	
Tue 6 Dec	FYI: Transient Drag and Flapping Flight	
Wed 7 Dec	Course Review	Review

See ATL for a colour schedule, list of suggested practice problems for each lecture topic, and the lab schedule.

ACCREDITATION LEARNING OUTCOMES

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

Outcomes	Indicators
Student can accurately determine the pressure drop and flow relationship for real laminar or turbulent flows in pipes and ducts.	1.4 Specialized Engineering Knowledge
Student can apply the heat diffusion equation, empirical convection coefficients and Fourier's law to determine the steady-state or transient temperature distribution in a solid.	1.4 Specialized Engineering Knowledge
Student recognizes the fluidics and heat transfer principles and cites the appropriate sources and equations in their laboratory reports. Discuss this theory in relation to the laboratory goals and objectives. Can research and present the limitations of the equipment with respect to achieving the objectives including estimating the sizes of uncertainties and their potential impact.	3.1 Recognize Appropriate Theory Base
Student recognizes the criteria and constraints in an open ended design problem and provides several alternative solutions. Student can select the most appropriate solution method and discuss its advantages against other options.	4.3 Proposes Solutions to Open Ended Problems.
Student constructs a laboratory report which describes the relevant theory and important sources of information. Student collects data and screens it for appropriateness. Discusses uncertainty in the data and cites appropriate literature in comparison to their results and measurements.	7.3 Effective Written Arguments

For more information on Accreditation, please direct enquirers to the Department of Engineering Physics (engphys@mcmaster.ca).

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.

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.

It is your responsibility to understand what constitutes academic dishonesty. For information on the various types of academic dishonesty please refer to the Academic Integrity Policy, located at <http://www.mcmaster.ca/academicintegrity>

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.

ACADEMIC ACCOMMODATIONS

Students who require academic accommodation must contact Student accessibility Services (SAS) to make arrangements with a Program Coordinator. Academic accommodations must be arranged for each term of study. Student Accessibility Services can be contact by phone at 905.525.9140 ext. 28652 or e-mail at sas@mcmaster.ca. For further information, consult McMaster University's Policy for [Academic Accommodation of Students with Disabilities](#).

NOTIFICATION OF STUDENT ABSENCE AND SUBMISSION OF REQUEST FOR RELIEF FOR MISSED ACADEMIC WORK

1. The [McMaster Student Absence Form](#) is a self-reporting tool for Undergraduate Students to report absences DUE TO MINOR MEDICAL SITUATIONS that last up to 3 days and provides the ability to request accommodation for any missed academic work. Please note this tool cannot be used during any final examination period.
2. You may submit a maximum of 1 Academic Work Missed request per term. It is YOUR responsibility to follow up with your Instructor immediately (NORMALLY WITHIN TWO WORKING DAYS) regarding the nature of the accommodation. Relief for missed academic work is not guaranteed.
3. If you are absent for reasons other than medical reasons, for more than 3 days, or exceed 1 request per term you MUST visit the Associate Dean's Office (JHE/A214). You may be required to provide supporting documentation.
4. This form must be submitted during the period of absence or the following day, and is only valid for academic work missed during this period of absence.
5. It is the prerogative of the instructor of the course to determine the appropriate relief for missed term work in his/her course.
6. You should expect to have academic commitments Monday through Saturday but not on Sunday or statutory holidays. If you require an accommodation to meet a religious obligation or to celebrate an important religious holiday, you may submit the Academic Accommodation for Religious, Indigenous and Spiritual Observances (RISO) Form to the Associate Dean's Office. You can find all paperwork needed here: <http://www.eng.mcmaster.ca/current/documents.html>

For Eng Phys 3004, any MSAF'd material will have its weight moved to the final exam.

NOTICE REGARDING POSSIBLE COURSE MODIFICATION

The instructor and university reserve the right to modify elements of the course during the term. The university may change the dates and deadlines for any or all courses in extreme circumstances. If either type of modification becomes necessary, reasonable notice and communication with the students will be given with explanation and the opportunity to comment on changes. It is the responsibility of the student to check their McMaster email and course websites weekly during the term and to note any changes.

ON-LINE STATEMENT FOR COURSES REQUIRING ONLINE ACCESS OR WORK

In this course, we will be using Avenue to Learn. Students should be aware that, when they access the electronic components of this course, 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 this course will be deemed consent to this disclosure. If you have any questions or concerns about such disclosure, please discuss this with the course instructor.

REFERENCE TO RESEARCH ETHICS

The two principles underlying integrity in research in a university setting are these: a researcher must be honest in proposing, seeking support for, conducting, and reporting research; a researcher must respect the rights of others in these activities. Any departure from these principles will diminish the integrity of the research enterprise. This policy applies to all those conducting research at or under the aegis of McMaster University. It is incumbent upon all members of the university community to practice and to promote ethical behaviour. To see the Policy on Research Ethics at McMaster University, please go to <http://www.mcmaster.ca/policy/faculty/Conduct/ResearchEthicsPolicy.pdf>.

ADDITIONAL LAB SAFETY INFORMATION

INTRODUCTION

This document describes the application of McMaster's Workplace Environmental Health and Safety Policy to the particular situation of undergraduate labs in the Engineering Physics Department. The policy is written for students, but applies to all people involved in the labs.

McMaster's Workplace Environmental Health and Safety Policy is reviewed by the Central Joint Health and Safety Committee each year as well as signed by our University President.

The policy applies to students, visitors and volunteers.

The policy is available at <http://www.workingatmcmaster.ca/eohss/prevention/policy/>

CHAIN OF REPORTING FOR SAFETY TRAINING AND RESPONSIBILITY

You will be provided with a health and safety lecture at the beginning of the first lab. **You are responsible for ensuring that you understand this safety information.** The lab technician is responsible for ensuring that all equipment is in good working order. In the event of an emergency, notify your Teaching Assistant (TA) and the lab technician. They are responsible for calling medical aid if needed. You must report any hazardous situation of concern to one level up according to the chart below. In case this person is not available, either contact the person delegated in their absence or the person positioned at the next level up. **You are expected to know this chain of reporting.**

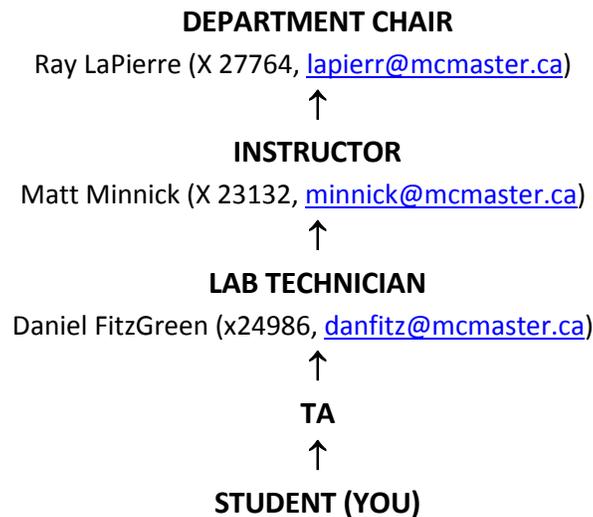


FIGURE 1. CHAIN OF COMMAND FOR HAZARD REPORTING.

PROPER LAB BEHAVIOUR

Everyone in the lab is responsible for their own safety as well as the safety of others.

GENERAL GUIDELINES

1. Conduct yourself in a **responsible** manner at all times in the laboratory.
2. Follow all written and verbal instructions carefully. If you do not understand a direction or part of a procedure, **ASK YOUR TA or LAB TECHNICIAN BEFORE PROCEEDING WITH THE ACTIVITY.**
3. **Never work alone** in the laboratory.
4. Perform only those experiments indicated by the lab manual or your TA/lab technician. Carefully **follow all instructions**, both written and oral. Unauthorized experiments are not allowed.
5. **Do not eat** food or drink beverages outside of the designated area in the laboratory. Do not use laboratory glassware as containers for food or beverages.
6. **Be prepared** for your work in the laboratory. Read all procedures thoroughly before entering the laboratory. Never fool around in the laboratory. Horseplay, practical jokes, and pranks are dangerous and prohibited.
7. Observe good housekeeping practices. Work areas should be kept **clean and tidy** at all times. Keep backpacks and overcoats out of traffic areas.
8. **Be alert** and proceed with caution at all times in the laboratory. Notify the TA or lab technician immediately of any unsafe conditions you observe.
9. Labels and equipment instructions must be read carefully. Set up and **use the equipment as directed** by your lab manual.
10. Experiments must be personally monitored at all times. Do not wander around the room, distract other students, startle other students or interfere with the laboratory experiments of others.
11. **Dress properly** during a laboratory activity. Long hair, dangling jewelry, and loose or baggy clothing are a hazard in the laboratory. Long hair must be tied back, and dangling jewelry and baggy clothing must be secured. **Proper footwear** must be worn, no flip flops, high heels, roller blades, etc..
12. **Report any accident** (spill, breakage, etc.) or injury (cut, burn, etc.) to the TA or lab technician immediately, no matter how trivial it seems.
13. **Cell phones and use of music headphones should be avoided** while working in the lab. They can be distracting and thereby increase the potential for an accident to occur.
14. Do not store food and drinks in refrigerators that are for lab supplies and vice versa
15. For specific safety guidelines (e.g., electrical, chemical, etc.), consult your lab manual and McMaster's lab safety handbook: <http://www.workingatmcmaster.ca/med/document/Lab-Safety-Handbook-1-36.pdf>

PROCEDURE TO FOLLOW IN THE CASE OF AN ACCIDENT

Know the locations and operating procedures of all safety equipment including: first aid kit(s), and fire extinguisher. Know where the fire alarm and the exits are located.

Know what to do if there is a fire drill during a laboratory period; turn off any electrical equipment in the event of a fire drill and leave the building.

In the case of an accident, notify your TA and the lab technician immediately. They will phone the emergency extension **88** in the event of an accident. Remain until medical aid arrives. If the TA or lab technician is unavailable, dial **88** yourself from a campus phone or 905-522-4135 (Security).