ENGG*3370 Applied Fluids and Thermodynamics

Winter 2015

UNIVERSITY of GUELPH
School of Engineering

(Revision 0: December, 2014)

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1 INSTRUCTIONAL SUPPORT

1.1 Instructor

Instructor: Shohel Mahmud, Ph.D., P.Eng.
Office: RICH 3519, ext. 54058
Email: smahmud@uoguelph.ca
Office hours: TBA on Courselink or by appointment

1.2 Lab Technician

Technician: Mike Speagle
Office: RICH 3502, ext. 56803
Email: mspeagle@uoguelph.ca

1.3 Teaching Assistants

GTA	Email	Office Hours
Adam Vogt	vogta@uoguelph.ca	TBA on Courselink
Jamie Minaret	jminaret@uoguelph.ca	TBA on Courselink
Ronil Rabari	rrabari@uoguelph.ca	TBA on Courselink

2 LEARNING RESOURCES

2.1 Course Website

Course material, news, announcements, and grades will be regularly posted to the ENGG*3370 Courselink site. You are responsible for checking the site regularly.

2.2 Required Resources

Thermodynamic Property Table by Y. Cengel and M. Boles

2.3 Recommended Resources

- Y. Cengel and M. Boles, **Thermodynamics: An Engineering Approach**, 8th Ed., McGraw-Hill, 2014.
- F.M. White, **Fluid Mechanics**, 7th Ed., McGraw-Hill, 2011.
- C.P. Arora, **Refrigeration and Air Conditioning**, 3rd Ed., McGraw-Hill, 2008.
- ASHRAE Handbook – Fundamentals (Chapters 17 and 21), American Society of Heating Refrigerating and Air-Conditioning Engineers, 2009.

2.4 Additional Resources

Lecture Information: A summary of the lecture notes will be posted on the courselink.

Lab Information: The lab manuals and lab schedule will be posted on the courselink. You are responsible for printing the lab manuals and having them with you during the laboratory sessions.

Home Assignments: There will be approximately 8 problem sets posted in Courselink during the term. These problem sets will not be marked, but it is recommended that you do each problem set, as practice problems are the best way to learn the course. All the solutions will be posted.

Miscellaneous Information: Other information related to Applied Fluids and Thermodynamics will be posted on the web page.

2.5 Communication & Email Policy

Please use lectures and lab help sessions as your main opportunity to ask questions about the course. Major announcements will be posted to the course website. **It is your responsibility to check the course website regularly**. As per university regulations, all students are required to check their <mail.uoguelph.ca> e-mail account regularly: e-mail is the official route of communication between the University and its student.

3 ASSESSMENT

3.1 Dates and Distribution

Assignments (0%): Approximately 8 Problem Sets

Quizzes and Tutorials (5%): Each tutorial is divided into two parts. In the first part (see Sections 5.3.1 and 5.3.2 for details), your GTA will solve and discuss one problem. In the second part of your tutorial (see Sections 5.3.1 and 5.3.2 for details) you will be asked to solve a problem. You need to make a group of two students (including yourself) for solving the problem in the second part of the tutorial. At the end of each tutorial you must submit your solution to your GTA for marking. A total 5% mark is allocated for such problem solving activities. You are heavily encouraged to attend your Registered Section of tutorial regularly.

Labs (15%): The purpose of performing the Applied Fluids and Thermodynamics Lab is to verify a portion of the theoretical learning in your lectures by conducting experiments. Applied Fluids and Thermodynamics Lab is located inside the "Sustainable Energy Lab (THRN 3402)". The detailed schedule will be posted on your courselink. Experiments are designed to cover most of the basic aspects of Applied Fluids and Thermodynamics. The 'Lab Manual' will be available in courselink. A total 15% mark is allocated for performing all lab components.

Midterm Exam (35%): Midterm Exam
Date: 10th February (Tuesday), 2015
Time: 6:00pm to 8:00pm
Location: RICH 2520

Final Exam (45%): Final Exam

Date: 7th April, 2015 (7:00pm to 9:00pm)
Time: TBA
Location: TBA

3.2 Course Grading Policies

Missed Assessments: If you are unable to meet an in-course requirement due to medical, psychological, or compassionate reasons, please email the course instructor. See the undergraduate calendar for information on regulations and procedures for Academic Consideration: http://www.uoguelph.ca/registrar/calendars/undergraduate/current/c08/c08-ac.shtml

Accommodation of Religious Obligations: If you are unable to meet an in-course requirement due to religious obligations, please email the course instructor within two weeks of the start of the semester to make alternate arrangements. See the undergraduate calendar for information on regulations and procedures for Academic Accommodation of Religious Obligations: http://www.uoguelph.ca/registrar/calendars/undergraduate/current/c08/c08-accomrelig.shtml

Missed Midterm Exam: If you miss a test due to grounds for granting academic consideration or religious accommodation, the weight of the missed test will be added to the final exam. **There will be no makeup midterm tests.**

Lab Work: **You must attend and complete all laboratories**. If you miss a laboratory due to grounds for granting academic consideration or religious accommodation, arrangements must be made with the teaching assistant to complete a makeup lab.

Late Lab Reports: Late submissions of lab reports will not be accepted.

Passing Grades: The passing grade of this course is 50%. In addition, you MUST pass the Final Exam.

4 AIMS, OBJECTIVES & GRADUATE ATTRIBUTES

4.1 Calendar Description

ENGG*3370 Applied Fluids and Thermodynamics W (3-2) [0.50]: This course builds on the fundamentals of fluid dynamics and thermodynamics introduced in previous courses by looking at relevant applications. Topics to be covered include: heating, ventilation and air conditioning (HVAC); heat engine systems such as the Carnot cycle for refrigeration and heat pumps and the Rankine cycle for vapour power systems; compressible flow, turbomachinery such as pumps, turbines, and propellers; and an introduction to combustion.

Prerequisite(s): ENGG*2230, ENGG*3260

Co-requisite(s): ENGG*3430

4.2 Course Aims

The fundamental knowledge obtained in the introductory Thermodynamics and Fluid Mechanics courses will be utilized to study and design the applied thermofluid systems. For example, power plant, refrigerator, heat pump, gas turbine, compressor, air-conditioning system, hydraulic pump, and hydraulic turbine, internal combustion engine, and jet engine.

4.3 Learning Objectives

On successful completion of this course, you should be able to:

1. Analyze different types of thermodynamic cycles
2. Apply thermodynamic cycles to practical devices
3. Evaluate the performance of ideal and real thermodynamic cycles
4. Differentiate between power generating and power consuming devices
5. Understand the properties of moist air and use the psychrometric chart as a tool to determine the properties of atmospheric air
6. Apply the principles of the conservation of mass and energy to various air-conditioning processes
7. Determine the cooling/heating load for rooms and buildings
8. Apply the conservation of mass to reacting systems to determine balanced reaction equations
9. Calculate the enthalpy of reaction, enthalpy of combustion, and the heating values of fuels
10. Develop the general relations for compressible flows encountered when gases flow at high speeds
11. Develop exergy balance equation and apply it for different thermofluid systems
12. Analyze different types of turbomachines and develop their performance parameters
13. Select an appropriate class of turbomachines for particular applications
14. Conduct Applied Fluids and Thermodynamic laboratory tests through collecting and analyzing data using the appropriate sensors and instruments and write clear, concise and professional laboratory reports
15. Demonstrate effective skills in teamwork during group activities; demonstrate respectful interactions with peers, lab technician, teaching assistants, and instructor, self assessment

4.4 Graduate Attributes

Graduate Attribute	Learning Objectives	Assessment
1. Knowledge Base for Engineering	1, 3, 5, 9	Quizzes, Labs, Exams
2. Problem Analysis	1 to 1 3	Quizzes, Exams
3. Investigation	14	Labs
4. Design	-	-
5. Use of Engineering Tools	14, 15	-
6. Communication	-	-
7. Individual and Teamwork	14, 15	-
8. Professionalism		-
9. Impact of Engineering on Society and the Environ.		-
10. Ethics and Equity	14, 15	-
11. Environ. Society, Business, & Proj. Management		-
12. Life-Long Learning		-

4.5 Instructor's Role and Responsibility to Students

The instructor's role is to develop and deliver course material in ways that facilitate learning for a variety of students. Selected lecture notes will be made available to students on Courselink/D2L but these are not intended to be stand-alone course notes. During lectures, the instructor will expand and explain the content of notes and provide example problems that supplement posted notes. Scheduled classes will be the principal venue to provide information and feedback for tests and project.

4.6 Students' Learning Responsibilities

Students are expected to take advantage of the learning opportunities provided during lectures and tutorials. Students, especially those having difficulty with the course content, should also make use of other resources recommended by the instructor. Students who do (or may) fall behind due to illness, work, or extra-curricular activities are advised to keep the instructor informed. This will allow the instructor to recommend extra resources in a timely manner and/or provide consideration if appropriate.

4.7 Relationships with other Courses & Labs

Previous Courses:

ENGG*2230: Steady and unsteady state; 1st law and Bernoulli equation; fluid flow rate and friction; laminar and turbulent flows; non-dimensional parameters (e.g., Reynolds number)

ENGG*2400: Modeling of engineering systems

MATH*2270: Solving differential equations

ENGG*3260: System and control volume; work and heat and their interaction with the boundary and direction; energy efficiency and effectiveness of systems; thermodynamic losses;

Follow-on Courses:

ENGG*3430: Foundation for application of heat transfer in various types of systems

ENGG*3470: Foundations of energy balances, thermal flow, thermal properties; Mass transfer through fluid flows (convection), thermal fluid properties

ENGG*3830: Foundations of heat and mass balance and bioreactor design

ENGG*4230: Foundations for design of energy conversion processes

ENGG*4300: Foundations for design of food engineering process

ENGG*4330: Foundation for performance analysis of combustion systems

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5 TEACHING AND LEARNING ACTIVITIES

5.1 Timetable

Lectures (Week 1 to Week 12)

Monday	11:30 am – 12:20 pm	ROZH 102
Wednesday	11:30 am – 12:20 pm	ROZH 102
Friday	11:30 am – 12:20 pm	ROZH 102

Tutorials (Week 1 to Week 12)

Wednesday	Sec 01	01:30 pm – 03:20 pm	THRN 3402
Wednesday	Sec 02	03:30 pm – 05.20 pm	THRN 3402
Friday	Sec 03	12:30 pm – 02:20 pm	THRN 3402
Monday	Sec 04	03:30 pm – 05.20 pm	THRN 3402
Monday	Sec 05	09:30 am – 11.20 pm	THRN 3402

Laboratory (Week 1 to Week 12)

Wednesday	Sec 01	01:30 pm – 03:20 pm	THRN 3402
Wednesday	Sec 02	03:30 pm – 05.20 pm	THRN 3402
Friday	Sec 03	12:30 pm – 02:20 pm	THRN 3402
Monday	Sec 04	03:30 pm – 05.20 pm	THRN 3402
Monday	Sec 05	09:30 am – 11.20 pm	THRN 3402

5.2 Lecture Schedule

The following table contains the tentative schedule of lecture topics and reading assignments.

Lectures	Lecture Topics	References	Learning Objectives
1, 2, 3, 4	Vapor and combined power cycles	[1]Chapter 10	1, 2, 3, 4
5, 6, 7, 8	Refrigeration cycles	[1]Chapter 11	1, 2, 3, 4
9	Introduction to turbomachinery	[2]Chapter 11	12
10, 11, 12	Hydraulic turbines	[2]Chapter 11	12, 13
13, 14, 15	Hydraulic pumps	[2]Chapter 11	12, 13

16, 17	Thermodynamics of gas-vapor mixture	[1]Chapter 14	1, 2, 5, 6
18, 19, 20, 21	Introduction to air-conditioning	[1]Chapter 14	2, 5, 6, 7
22, 23, 24	Introduction to combustion	[1]Chapter 15	8, 9
25, 26, 27, 28	Gas power and propulsion cycles	[1]Chapter 09	1, 2, 3, 4
29, 30, 31	Introduction to compressible flow	[1]Chapter 17, [2]Chapter 09	10
32, 33, 34, 35	Exergy - A measure of work potential	[1]Chapter 08	4, 11
36	Review		-

[1] Y. Cengel and M. Boles, Thermodynamics: An Engineering Approach, 8th Ed., McGraw-Hill, 2014.
[2] F.M. White, Fluid Mechanics, 7th Ed., McGraw-Hill, 2011.
[3] C.P. Arora, Refrigeration and Air Conditioning, 3rd Ed., McGraw-Hill, 2008.
[4] ASHRAE Handbook – Fundamentals (Ch.17 & Ch.21), American Soc. Heating Refrigerating and Air-Conditioning Engineers

5.3 Tutorial Schedule

5.3.1 Tutorial and Quiz: THRN 3402 and THRN 3404 (Sustainable Energy Lab) is booked for weekly tutorial. Each tutorial is 1 hour 50 minutes long. Your TA will solve and discuss a maximum of 2 problems in the first half of the tutorial (approximately 50 minutes – from Week 1 to Week 4). TA will also answer your question regarding the "Problem Set" available in the course website. You are going to solve one or two problems in the next half of the tutorial (approximately 50 minutes – from Week 1 to Week 4) as a part of the tutorial quiz. You need to make a group of two students (including yourself) for solving the problem in the second part of the tutorial. At the end of each tutorial you must submit your solution to your TA for marking. You are heavily encouraged to attend the tutorial regularly.

5.3.2 Tutorial, Quiz, and Lab Experiments: The purpose of performing the Lab is to verify some of the theoretical learning in our class by experiments. Applied Fluids and Thermodynamics Lab is located inside the "Sustainable Energy Lab (THRN 3402 and THRN 3404)". Lab experiments will be executed from Week 5 to Week 11. The class will be divided into two groups (maximum 12 students in each group). In the first hour, the first group will run the experiments and the second group will attend the tutorial and quiz (approximately 25 minutes for tutorial and 25 minutes for quiz). In the second hour, the second group will run the experiments and the first group will attend the tutorial and quiz (approximately 25 minutes for tutorial and 25 minutes for quiz). You need to make a team of five students (including yourself) for performing the experiment. 'Lab Manual' and schedule will be available in the COURSE LINK.

5.4 Lab Schedule‡

Week	Topic
5, 6	Cooling load and COP calculations of refrigeration cycle **Equipment**: Heat pump setup
5,6	Special refrigeration systems (a) COP calculation of Thermoelectric Refrigerator and (b) vortex tube coolers **Equipment**: thermoelectric refrigerator, vortex tube cooler, and thermoacoustic cooler

7,8	Performance calculation of an Impulse Turbine **Equipment**: Pelton Wheel Turbine
7,8	Performance calculation of a Reaction Turbine **Equipment**: Francis Turbine
7,8	Performance calculation of a Rotadynamic Pump **Equipment**: Centrifugal pump setup
7,8	Performance calculation of a Positive Displacement Pump **Equipment**: Reciprocating pump setup
9	Power and efficiency calculation of a steam power plant **Equipment**: Mini steam power plant
9	Analysis of different air-conditioning systems **Equipment**: Complete HVAC setup
9	**Demonstration** of a window air-conditioner **Equipment**: Window type air-conditioning unit
10, 11	Calculation of the heating values of a solid fuel and a liquid fuel **Equipment**: Bomb calorimeter
10, 11	Exergy analysis of a body loosing heat **Equipment**: Transient cooling of hot water experimental setup
10, 11	**Demonstration** of Stirling Engine Equipment: low ΔT Stirling engine, medium ΔT Stirling engine, and high ΔT Stirling engine in Sustainable Energy Lab)

‡ Students must submit 2 lab reports. **Report 1** is based on the first 5 experiments (demo excluded) and is due one week after the 5th experiment. **Report 2** is based on the last 5 experiments (demo excluded) and is due one week after the 10th experiment.

5.5 Other Important Dates

Monday, 5th January, 2015: Winter 2015 Semester Starts

Monday, 5th January, 2015: First lecture of Heat and Mass Transfer

Monday, 16th February, 2015 to Friday, 20th February, 2015: Winter Break

Friday, 6th March, 2015: 40th class day – Last day to drop one semester courses

Thursday, 2nd April, 2015: Classes conclude

Monday, 6th April, 2015: Examinations commence

6 LAB SAFETY

Safety is critically important to the School and is the responsibility of all members of the School: faculty, staff and students. As a student in a lab course you are responsible for taking all reasonable safety precautions and following the lab safety rules specific to the lab you are working in. In addition, you are responsible for reporting all safety issues to the laboratory supervisor, GTA or faculty responsible. If the laboratory rules are not followed, consequences will include removing access to the lab. If these results in lab work not being completed, the student will receive a grade of 0.

All students must require a basic safety related training. Please complete the online **WHMIS** (Workplace Hazardous Materials Information System) training before the first lab experiment session. Please visit Environmental Health and Safety website (http://www.uoguelph.ca/ehs/courses/login.cfm) for registration and additional information. Your GTA and Lab Technician may ask you to show them a copy of the WHMIS completion certificate anytime during your lab session.

6.1 Specific for ENGG*3370:

- You must read and follow safety rules posted on the door of the Sustainable Energy Lab (THRN3402).
- You must read the experiment manuals carefully. You will find additional safety requirement related to specific excrements in the manuals. Follow them accordingly.
- Always wear safety glasses during lab time.
- Your lab technician and teaching assistants will deliver a short lecture on lab safety during the first lab session.

7 ACADEMIC MISCONDUCT

The University of Guelph is committed to upholding the highest standards of academic integrity and it is the responsibility of all members of the University community faculty, staff, and students to be aware of what constitutes academic misconduct and to do as much as possible to prevent academic offences from occurring. University of Guelph students have the responsibility of abiding by the University's policy on academic misconduct regardless of their location of study; faculty, staff and students have the responsibility of supporting an environment that discourages misconduct. Students need to remain aware that instructors have access to and the right to use electronic and other means of detection.

Please note: Whether or not a student intended to commit academic misconduct is not relevant for a finding of guilt. Hurried or careless submission of assignments does not excuse students from responsibility for verifying the academic integrity of their work before submitting it. Students who are in any doubt as to whether an action on their part could be construed as an academic offence should consult with a faculty member.

7.1 Resources

The Academic Misconduct Policy is detailed in the Undergraduate Calendar:
http://www.uoguelph.ca/registrar/calendars/undergraduate/current/c08/c08-amisconduct.shtml

A tutorial on Academic Misconduct produced by the Learning Commons can be found at:
http://www.academicintegrity.uoguelph.ca/

Please also review the section on Academic Misconduct in your Engineering Program Guide.

The School of Engineering has adopted a Code of Ethics that can be found at:
http://www.uoguelph.ca/engineering/undergrad-counselling-ethics

8 ACCESSIBILITY

The University of Guelph is committed to creating a barrier-free environment. Providing services for students is a shared responsibility among students, faculty and administrators. This relationship is based on respect of individual rights, the dignity of the individual and the University community's shared commitment to an open and supportive learning environment. Students requiring service or accommodation, whether due to an identified, ongoing disability for a short-term disability should contact the Centre for Students with Disabilities as soon as possible.

For more information, contact CSD at 519-824-4120 ext. 56208 or email csd@uoguelph.ca or see the website: http://www.csd.uoguelph.ca/csd/

9 RECORDING OF MATERIALS

Presentations which are made in relation to course work—including lectures—cannot be recorded or copied without the permission of the presenter, whether the instructor, classmate or guest lecturer. Material recorded with permission is restricted to use for that course unless further permission is granted.

10 RESOURCES

The Academic Calendars are the source of information about the University of Guelph's procedures, policies and regulations which apply to undergraduate, graduate and diploma programs: http://www.uoguelph.ca/registrar/calendars/index.cfm?index