ENGG*3260 Thermodynamics

Fall 2017

School of Engineering

(Revision 1: Aug 30th 2017)

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1 INSTRUCTIONAL SUPPORT

1.1 Instructor

Instructor: Wael Ahmed, PhD
Office: RICH 2507, ext. 53674
Email: ahmedw@uoguelph.ca
Office hours: Mondays 10:30-11:30 AM and Wednesdays 1:00-2:00 PM

1.2 Lab Technician

Technician: Mike Speagle
Office: RICH 1507, ext. 56803
Email: mspeagle@uoguelph.ca

1.3 Teaching Assistants

GTA	Email	Office Hours
Baljeet Kaur	baljeet@uoguelph.ca	TBA on Courselink
Andrew Eaton	eatona@uoguelph.ca	TBA on Courselink
Ramandeep Sandhu	ramandee@uoguelph.ca	TBA on Courselink
Adib Fatayerji	afatayer@uoguelph.ca	TBA on Courselink
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Yasaman Daneshi	ydaneshi@uoguelph.ca	TBA on Courselink
Braden Kelly	bkelly08@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*3260 Courselink site. You are responsible for checking the course website regularly.

2.2 Required Resources

Property tables

2.3 Recommended Resources

Yunus A. Çengel and Michael A. Boles. Thermodynamics–An Engineering Approach, 8th edition, McGraw Hill Higher Education

2.4 Additional Resources

Lecture Information: Lecture presentations will be posted on the Courselink.

Lab Information:

The handouts for all the lab sessions will be available on the Courselink and during the lab section. All types of resources regarding tutorials, links to web pages can be found in this section.

Home Assignments:

Download the assignments according to the schedule given in this handout. All the solutions will be posted as indicated.

Miscellaneous Information:

Other information related to Thermodynamics is also 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 e-mail account (<username>@mail.uoguelph.ca) regularly. E-mail is the official route of communication between the University and its student.

3 ASSESSMENT

3.1 Dates and Distribution

Quizzes: 10% (4 quizzes conducted during tutorials)
Week 3, in tutorial
Week 5, in tutorial
Week 10, in tutorial
Week 11, in tutorial

Labs: 10%
See section 5.4 below for due dates

Midterm test (In-Class): 25%
Friday Oct 20, 2017 Time: 9:30 am -10:15 am, ROZH, Room 103

Final Exam: 55%
Tuesday Dec 5, 2017 Time: 8:30-10:30 am, Room TBA on Webadvisor

Important Note Regarding Exams: Formula sheet will be provided to you with the exams.

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 test: 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 is 50%.

4 AIMS, OBJECTIVES & GRADUATE ATTRIBUTES

4.1 Calendar Description

This course covers macroscopic thermodynamics and its applications to engineering practice. Topics include properties of pure substances and equilibrium, the First Law of thermodynamics (energy transfer and energy balance in closed and flow systems), the Second Law of thermodynamics and its applications (entropy analysis of closed and flow systems, quantification of irreversibilities and inefficiencies, quality of energy, etc.), thermodynamic cycles and exergy.

Prerequisite(s): CHEM*1040, ENGG*2230, ENGG*2400, MATH*2270

4.2 Course Aims

This course aims at familiarizing the students with fundamental principles of thermodynamics, thermodynamic tools, and their applications for real world energy systems. The overall theme of this course is the application of the first and second laws of thermodynamics to engineering applications related to flow devices, power generation, and air-conditioning. Students also expected to understand how thermodynamic properties are related to each other. In the analysis of steady flow devices, students shall be able to make necessary simplifications and be able to apply correctly both the First Law and Second Law of thermodynamics. In the analysis of power generation cycles, students are expected to formulate appropriate idealized thermodynamic process models and analyze cycle efficiency. In the analysis of heating, ventilation, and air conditioning systems, the students are expected to simply analyse heating, ventilation, and air-conditioning systems based on first and second law of thermodynamics.

4.3 Learning Objectives

At the successful completion of this course, the student will have demonstrated the ability to:

1. State the First Law and to define heat, work, thermal efficiency and the difference between various forms of energy.
2. Identify and describe energy exchange processes (in terms of various forms of energy, heat and work) in thermodynamic systems.
3. Determine properties of real substances, such as steam and refrigerant R134-a, and ideal gases from either tabular data or equations of state.
4. Analyze processes involving ideal gases and real substances as working fluids in both closed systems and open systems or control volumes to determine process diagrams, apply the first law of thermodynamics to a system of thermodynamic components (heaters, coolers, pumps, turbines, pistons, etc.) to perform energy balances, and determine heat and work transfers.
5. Analyze systems and control volumes through the application of the second law and explain the concepts of path dependence/independence and reversibility/irreversibility of various thermodynamic processes, to represent these in terms of changes in thermodynamic state, and to cite examples of how these would impact the performance of energy systems.
6. Analyze ideal gas and steam power cycles and refrigeration cycles to determine system components and process diagrams, perform energy balances, determine heat and work

transfers, calculate the cycle efficiency or coefficient of performance and design power/refrigeration cycles or processes for cycle components.

4.4 Graduate Attributes

Successfully completing this course will contribute to the following CEAB Graduate Attributes:

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

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 ***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:

CHEM*1040: Understanding of chemical equilibrium, stoichiometry

ENGG*2230: Steady and unsteady state, 1st law and Bernoulli equation.

ENGG*2400: Modeling of engineering systems

MATH*2270: Solving differential equations

Follow-on Courses:

ENGG*3370: Foundation for analysis of thermo-fluid systems

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

ENGG*3470: Foundations of energy balances, thermal flow, thermal 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:			
Monday		9:30 am-10:20 am	ROZH, Room 103
Wednesday		9:30 am-10:20 am	ROZH, Room 103
Friday		9:30 am-10:20 am	ROZH, Room 103
Tutorials:			
Tuesday	Sec 0101	10:30 am-12:20 am	MCKN, Room 229
Tuesday	Sec 0102	1:30 pm-3:20 pm	MINS, Room 106
Tuesday	Sec 0103	3:30 pm- 5:20 pm	MCKN, Room 223
Thursday	Sec 0104	10:30 am- 12:20 pm	MACN, Room 236
Thursday	Sec 0105	1:30 pm-3:20 pm	MCKN, Room 236
Thursday	Sec 0106	3:30 pm-5:20 pm	MCKN, Room 223
Monday	Sec 0107	10:30 am-12:20 pm	MCKN, Room 236
Wednesday	Sec 0108	10:30 am - 12:20 pm	MINS, Room 017
Friday	Sec 0109	10:30 am- 12:20 pm	MINS, Room 017
Friday	Sec 0110	1:30 pm-3:20 pm	ANNU, Room 204
Laboratory*:			
Tuesday	Sec 0101	10:30 am-12:20 am	THRN 3402 &3404
Tuesday	Sec 0102	1:30 pm-3:20 pm	THRN 3402 &3404
Tuesday	Sec 0103	3:30 pm- 5:20 pm	THRN 3402 &3404
Thursday	Sec 0104	10:30 am- 12:20 pm	THRN 3402 &3404
Thursday	Sec 0105	1:30 pm-3:20 pm	THRN 3402 &3404

Thursday	Sec 0106	3:30 pm-5:20 pm	THRN 3402 &3404
Monday	Sec 0107	10:30 am-12:20 pm	THRN 3402 &3404
Wednesday	Sec 0108	10:30 am - 12:20 pm	THRN 3402 &3404
Friday	Sec 0109	10:30 am- 12:20 pm	THRN 3402 &3404
Friday	Sec 0110	1:30 pm-3:20 pm	THRN 3402 &3404

* **Please see Sections 5.3 and 5.4 for Lab schedule**

5.2 Lecture Schedule

Lectures	Lecture Topics	References	Learning Objectives
1-3	Introduction, Basic Concepts, units, dimensional homogeneity, Closed and open systems, Control volumes, Equilibrium Pressure, Temperature, manometer, atmospheric pressure	Chapter 1	1
4-6	Forms of Energy, heat, work, Mechanical forms of work, first law of thermodynamics, Energy efficiencies	Chapter 2	1,2
7-10	Properties of Pure Substances, phase change, Property diagrams and tables, Property tables, ideal gas equation, other equations of state	Chapter 3	1,3
11-13	Energy analysis of closed systems, moving boundary work, energy balance, Specific heats, internal energy, enthalpy Ideal Gas	Chapter 4	1,2,3,4
14-17	1st law control volumes, conservation of mass, flow work, Energy analysis of steady flow, SS devices, unsteady flow	Chapter 5	1,2,3,4
18-19	Review and midterm exam		1-6
20-23	Intro to 2nd law of thermodynamics, Thermal reservoirs, heat engines, Refrigeration & heat pumps, perpetual motion machines, reversible and irreversible processes, Carnot cycle, principles, temperature scale, Carnot heat engine, Carnot Refrigeration and heat pump	Chapter 6	3,4,5
24-28	Entropy, increase of entropy principles, Entropy change in pure substances, isentropic process, T- ds relations, Reversible steady-flow work, isentropic efficiencies of steady flow devices, entropy balance	Chapter 7	3,4,5
29-32	Analysis of Power Cycles, Carnot Cycle, Air standard assumptions, Otto cycle, Diesel cycle, Rankine cycle, Rankine cycle, deviations from ideal efficiency, Ideal Reheat Rankine cycle, Ideal Regenerative Rankine cycle, combined gas-power cycles	Chapter 9 & 10	3,4,5,6
33-34	Refrigerators and heat pumps, revised Carnot cycle, Ideal and actual vapour-compression refrigeration cycles. Review of Chapter 6-11	Chapter 11	3,4,5,6

35-36	Reviews	1-6

5.3 Tutorial Schedule

Week	Activity
1	Introduction on lab equipment, lab safety, and experiments on conservation of energy
2	Problem solving on Chapter 2
3	Problem solving on Chapter 3 and quiz on chapter 2
4	Problem solving on Chapter 4
5	Problem solving on Chapter 5 and quiz on chapter 4
6	Reviews for midterm
7	Labs
8	Labs
9	Labs and Problem solving on Entropy (Chapter 6 and 7)
10	Problem solving on Entropy (Chapter 7) and quiz on chapter 6
11	Problem solving on cycles (Chapter 9 and 10) and quiz on chapter 7
12	Problem solving on cycles (Chapter 11)

5.4 Lab Schedule

Week	Topic	*Due
1	Introduction to Lab Equipment and Safety Training & Experiments on conservation of energy	Next day by 5 pm
7,8,9	Experiments on calculation of higher heating value of fuel using bomb calorimeter	Next day by 5 pm
7,8,9	Experiment on calculation of Coefficient of Performance (COP) of heat pump	Next day by 5 pm
7,8,9	Experiments on finding saturation pressure of water at various temperature	Next day by 5 pm

*Please note that a **Dropbox** in the course link will created for each lab and the late submissions will not be graded (**Zero grad will be assigned**). Submission should be done by 5 pm next day to the lab and if you have a lab on Friday, the lab reports will be due on the following Monday by 5 pm.

5.5 Other Important Dates

Friday, 8 September 2017: First class

Monday, 11 September 2017: First Lab

Monday, 9 October 2017: Holiday (No classes)

Tuesday, 10 October 2017: Fall study day (No classes)

Friday, 3 November 2017: Last day to drop

Friday, 1 December 2016: Classes conclude

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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.

6.1 Sustainable Energy Lab Safety

This section outlines some of the safety related procedures and information for use in the Sustainable Energy Lab in THRN 3402. Safety in the laboratory is critical. **You will not be allowed to do the project or the labs unless you attend the safety session and sign a form indicating that you have done so.** You must have **WHMIS** (Workplace Hazardous Materials Information System) training before the first lab experiment session. Visit Environmental Health and Safety website (https://www.uoguelph.ca/ehs/node/975) 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. If you have any concerns or comments related to safety in this laboratory you can reach Mr. Mike Speagle, at ext. 56803, in THRN 3502.

1. Be prepared. You should download and print a copy of the ENGG*3260 Lab Manual from Courselink. Be sure to carefully read the specific manual section before you go to perform each of the laboratory exercises.
2. You must do as instructed by the laboratory demonstrator. If you are not sure about something ask the demonstrator. Inform the demonstrator if you become aware of a potential hazard.
3. Food and beverages cannot be stored or consumed in this laboratory
4. Safety glasses are mandatory for all experiments. You will not be allowed to perform an experiment without them.
5. Proper footwear is mandatory for all the experiments. This means no open toed shoes or sandals.
6. The fire extinguisher, first aid kit, and phone are located at the front of the lab (THRN 3402). Dial ext. 52000 in case of emergencies.
7. All accidents should be reported to the demonstrator.

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, a 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