



# ENGG\*3260 Thermodynamics

Fall 2019

Section(s): C01,C02

School of Engineering

Credit Weight: 0.50

Version 1.00 - September 04, 2019

## 1 Course Details

### 1.1 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.

**Pre-Requisites:** CHEM\*1040, ENGG\*2230, ENGG\*2400, MATH\*2270

### 1.2 Timetable

**Lectures:**

Section #	Days	Time	Location	Instructor
1xx	Monday, Wednesday, and Friday	12:30 PM - 1:20 PM	ROZH, Room 103	Dr. Elsharqawy
2xx	Monday and Wednesday	5:30 PM - 6:50 PM	ROZH, Room 103	Dr. Komeili

**Tutorials/Labs:**

Section #	Days	Time	Location*	GTA
201	Monday	11:30AM - 01:20PM	MCKN 317	Metwalli & Madanpotra

Section #	Days	Time	Location*	GTA
105/205	Monday	01:30PM - 03:20PM	MCKN 313	Metwalli & Madanpotra
102/202	Monday	03:30PM - 05:20PM	MCKN 304	Abdelkader & Sharma
104/204	Tuesday	11:30AM - 01:20PM	MCKN 313	Metwalli & Abdelkader
106/206	Tuesday	01:30PM - 03:20PM	MCKN 313	Moradi & Abdelkader
203	Wednesday	11:30AM - 01:20PM	ALEX 218	Moradi & Kaur
107/207	Wednesday	01:30PM - 03:20PM	MCKN 313	Moradi & Boules
110/210	Wednesday	03:30PM - 05:20PM	MCKN 316	Kaur & Sharma
108/208	Thursday	01:30PM - 03:20PM	MCKN 313	Madanpotra & Boules
109/209	Friday	01:30PM - 03:20PM	MCKN 313	Kaur & Sharma

\*Weeks with Lab activity (weeks #1, 5, & 11), the tutorial and lab will be in THRN 3402 & THRN 3404

## 1.3 Final Exam

Wednesday **December 4, 2019**. Time: 8:30 am – 10:30 am, Room TBA on WebAdvisor

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## 2 Instructional Support

### 2.1 Instructional Support Team

**Instructor:** Mostafa Elsharqawy (Section 01)  
**Email:** melsharq@uoguelph.ca  
**Telephone:** +1-519-824-4120 x54017  
**Office:** RICH 3513

**Instructor:** Amin Komeili (Section 02)  
**Email:** akomeili@uoguelph.ca  
**Telephone:** +1-519-824-4120, ext. 54741  
**Office:** RICH-1509  
**Office Hours:** Tuesday 10:00 – 11 AM

**Lab Technician:** Michael Speagle  
**Email:** mspeagle@uoguelph.ca  
**Telephone:** +1-519-824-4120 x56803  
**Office:** RICH 1102

### 2.2 Teaching Assistants

**Teaching Assistant:** David Boules  
**Email:** boulesd@uoguelph.ca  
**Office:** THRN 1425  
**Office Hours:** Thursday 12 – 1 PM

**Teaching Assistant:** Mohamed Metwalli  
**Email:** mmetwall@uoguelph.ca  
**Office:** THRN 1425  
**Office Hours:** Thursday 11 AM – 12 PM

**Teaching Assistant:** Mohsen Moradi  
**Email:** moradim@uoguelph.ca

<b>Office:</b>	THRN 1425
<b>Office Hours:</b>	Tuesday 12:30 – 1:30 PM
<b>Teaching Assistant:</b>	Gaganjot Madanpotra
<b>Email:</b>	gmadanpo@uoguelph.ca
<b>Office:</b>	THRN 1425
<b>Office Hours:</b>	Tuesday 1:30 – 2:30 PM
<b>Teaching Assistant:</b>	Prabhjot Kaur
<b>Email:</b>	pkaur07@uoguelph.ca
<b>Office:</b>	THRN 1425
<b>Office Hours:</b>	Friday 11 AM – 12 PM
<b>Teaching Assistant:</b>	Sonu Sharma
<b>Email:</b>	sonu@uoguelph.ca
<b>Office:</b>	THRN 1425
<b>Office Hours:</b>	Friday 12 – 1 PM
<b>Teaching Assistant:</b>	Bassel Abdelkader
<b>Email:</b>	babdelka@uoguelph.ca
<b>Office:</b>	THRN 1425
<b>Office Hours:</b>	Wednesday 12:30 – 1:30 PM

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## 3 Learning Resources

### 3.1 Required Resources

#### Property Tables (Readings)

Property tables will be posted on CourseLink as PDF file and you can print it to be used in quizzes and tests.

### 3.2 Recommended Resources

#### Course Website (Website)

Course material, news, announcements, and grades will be regularly posted to the ENGG\*3260 Courselink website. You are responsible for checking the website regularly.

**Yunus A. Çengel and Michael A. Boles. Thermodynamics–An Engineering Approach, 9th edition, McGraw Hill Higher Education (Textbook)**

### 3.3 Additional Resources

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

#### Lab Information:

The handouts for the labs will be available on Courselink and during the lab time.

#### Home Assignments:

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

**Communication and Email Policy:**

Please use lectures and tutorials as your main opportunity to ask questions about the course. Electronic communication should be limited to the discussion forum on Courselink, however, topics of a personal and confidential nature (e.g. marks) should be emailed to the respective instructor. Please note that all email communications must be made through your University of Guelph email account.

**Miscellaneous Information:**

Lectures are the main source of material and include important discussions and worked examples that might not be found elsewhere. Other information related to Thermodynamics are also posted on Courselink.

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## 4 Learning Outcomes

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 are 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 the first and second law of thermodynamics.

### 4.1 Course Learning Outcomes

By the end of this course, you should be able 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.
7. Use appropriate apparatus, sensors and instruments to collect data and analyze a system by conducting laboratory tests.
8. Write clear and concise laboratory reports for the labs.
9. Demonstrate effective skills in teamwork during group activities (tutorials and laboratories) and respectful interactions with peers, lab technicians, graduate teaching assistants, and instructor during lectures, weekly tutorials and laboratories.

## 4.2 Engineers Canada - Graduate Attributes (2018)

Successfully completing this course will contribute to the following:

#	Outcome	Learning Outcome
1	Knowledge Base	1, 2, 3, 4, 5
1.1	Recall, describe and apply fundamental mathematical principles and concepts	1, 2, 3, 4, 5
1.2	Recall, describe and apply fundamental principles and concepts in natural science	1, 2, 3, 4, 5
1.3	Recall, describe and apply fundamental engineering principles and concepts	1, 2, 5
1.4	Recall, describe and apply program-specific engineering principles and concepts	1, 2, 5
2	Problem Analysis	1, 2, 3, 4, 5, 6
2.1	Formulate a problem statement in engineering and non-engineering terminology	5
2.2	Identify, organize and justify appropriate information, including assumptions	1, 2, 3, 4, 5, 6

#	Outcome	Learning Outcome
2.3	Construct a conceptual framework and select an appropriate solution approach	1, 2, 3, 4, 5, 6
2.4	Execute an engineering solution	1, 2, 3, 4, 5, 6
2.5	Critique and appraise solution approach and results	1, 2, 4, 5
3	Investigation	7
3.3	Analyze and interpret experimental data	7
5	Use of Engineering Tools	1
5.1	Select appropriate engineering tools from various alternatives	1
6	Individual & Teamwork	9
6.2	Understand all members' roles and responsibilities within a team	9
6.3	Execute and adapt individual role to promote team success through, for example, timeliness, respect, positive attitude	9
7	Communication Skills	8
7.2	Interpret technical documentation such as device specification sheets, drawings, diagrams, flowcharts, and pseudocode	8
7.3	Construct the finished elements using accepted norms in English, graphical standards, and engineering conventions, as appropriate for the message and audience	8
7.5	Demonstrate ability to process oral and written communication by following instructions, actively listening, incorporating feedback, and formulating meaningful questions	8

## 5 Teaching and Learning Activities

### 5.1 Lecture Schedule

Week #	Lecture Topics	References	Learning Objectives
0	Introduction and course outline	Outline	1

1	Basic concepts, closed and open systems, equilibrium, pressure, temperature, and atmospheric pressure.  Forms of energy, heat, work, mechanical forms of work, first law of thermodynamics, and energy efficiency	Chapter 1  Chapter 2	1, 2
2	Properties of pure substances, phase change, property diagrams and tables, property tables, ideal gas equation, other equations of state	Chapter 3	1,3
3	Energy analysis of closed systems, moving boundary work, energy balance, specific heats, internal energy, and enthalpy.	Chapter 4	1,2,3,4
4, 5	1st law control volumes, conservation of mass, flow work, Energy analysis of steady flow and application to some devices.	Chapter 5	1, 2, 3, 4, 6
6, 7	Intro to 2nd law of thermodynamics, Thermal reservoirs, heat engines, Refrigeration & heat pumps, perpetual motion machines, reversible and irreversible processes, Carnot cycle, Carnot heat engine, Carnot reversed heat engine.	Chapter 6	3,4,5
8	Entropy, increase of entropy principle, Entropy change in pure substances, isentropic process, T- s relations, Reversible steady-flow work, isentropic efficiencies of steady flow devices, entropy balance	Chapter 7	3,4,5
9	Vapor power cycles, Rankine cycle, Reheat Rankine cycle, Regenerative Rankine cycle	Chapter 10	3,4,5,6



<b>5 . 2 T u t o</b>	10	Refrigerators and heat pumps, Ideal and actual vapour-compression refrigeration cycles.	Chapter 11	3,4,5,6
	11	Gas power cycles, Air standard assumptions, Otto cycle, Diesel cycle, Brayton cycle	Chapter 9	3,4,5,6
	12	Reviews on cycles	Ch. 9 – 11	1-6

### rial/Lab Schedule

Week #	Tutorial Activity	Lab Activity
1	Problem solving on Chapter 1	Lab 1 (lab safety)
2	Problem solving on Chapter 2 and <b>Quiz 1</b> (on Chapter 1)	-
3	Problem solving on Chapter 3 and <b>Quiz 2</b> (on Chapter 2)	-
4	Problem solving on Chapter 4 and <b>Quiz 3</b> (on Chapter 3)	-
5	Problem solving on Chapter 5	Lab 2 (saturation line)
6	Review and solve problems on Chapter 5	-
7	Problem solving on Chapter 6	-
8	Problem solving on Chapter 7 and <b>Quiz 4</b> (on Chapter 6)	-
9	Problem solving on Chapters 6&7 and <b>Quiz 5</b> (Chapter 7)	-

<b>5 · 3 I</b>	10	Problem solving on Chapter 10	-
	11	Problem solving on Chapter 11	Lab 3 (heat pump)
	12	Problem solving on Chapter 9 and <b>Quiz 6</b> (Chapter 10)	-

## Important Dates

- Thursday, September 5, 2019: First day of classes
  - Monday, October 14, 2019: Thanksgiving holiday (no classes)
  - Tuesday, October 15, 2019: Fall break study day (no classes)
  - Friday, November 29, 2019: Make up for Thanksgiving Day (Monday Schedule)
  - Thursday, November 28, 2019: Make up for Study Day (Tuesday Schedule)
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## 6 Assessments

### 6.1 Marking Schemes & Distributions

#### Assignments: 0%

Ten (10) unmarked assignments will be posted on CourseLink

#### Quizzes: 15%

Six (6) quizzes conducted during tutorials and scheduled in weeks 2, 3, 4, 8, 9, and 12

#### Labs: 10%

Two (2) labs scheduled in weeks 5 and 11

**Mid-term Test: 25%**

The mid-term exam is scheduled on Saturday 19<sup>th</sup> October 2019 at 12 pm, **Room TBA**

**Final Exam: 50%**

Wednesday 4th December 2019. Time: 8:30 - 10:30 am, Room TBA on WebAdvisor

**Important Note Regarding Exams:** A formula sheet will be provided in the exams.

## 6.2 Assessment Details

**Quiz 1 (2.5%)**

**Date:** Week 2, in tutorial

**Learning Outcome:** 1

**Quiz 2 (2.5%)**

**Date:** Week 3, in tutorial

**Learning Outcome:** 2

**Quiz 3 (2.5%)**

**Date:** Week 4, in tutorial

**Learning Outcome:** 4

**Quiz 4 (2.5%)**

**Date:** Week 8, in tutorial

**Learning Outcome:** 5

**Quiz 5 (2.5%)**

**Date:** Week 9, in tutorial

**Learning Outcome:** 6

**Quiz 6 (2.5%)**

**Date:** Week 12, in tutorial

**Learning Outcome:** 6

**Lab Report (10%)**

**Learning Outcome:** 7, 8, 9  
2 labs, each lab is worth 5%

**Midterm Test (25%)**

**Date:** Sat, Oct 19, 12:00 PM - , 1:30 PM, TBD  
**Learning Outcome:** 1, 2, 3, 4

**Final Exam (50%)**

**Date:** Wed, Dec 4, 8:30 AM - , 10:30 AM  
**Learning Outcome:** 4, 5, 6  
Location will be announced on Webadvisor

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## 7 Course Statements

### 7.1 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.

**Lab Reports:** Lab reports should be submitted online to CourseLink Dropbox folder. The report submission due is 1 week after the lab scheduled day. Any reports submitted later will not be accepted.

**Passing Grades:** The passing grade is 50%.

**Questions Concerning Grades:** If you have questions about the grade of your test received, please ask your TA within one week of the document being returned. However, all requests for re-marking must be made to the instructor. Any item that is re-marked will be re-marked

entirely. Therefore, it is strongly suggested that you thoroughly review your entire document before making a re-marking request. Pencil-written works will not be re-marked. Re-marking requests will not be honoured more than one week after the document has been returned.

## **8 School of Engineering Statements**

### **8.1 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. Some written lecture notes will be presented only in class. 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 labs.

### **8.2 Students' Learning Responsibilities**

Students are expected to take advantage of the learning opportunities provided during lectures and lab sessions. 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.

### **8.3 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.

## **9 University Statements**

### **9.1 Email Communication**

As per university regulations, all students are required to check their e-mail account regularly: e-mail is the official route of communication between the University and its students.

### **9.2 When You Cannot Meet a Course Requirement**

When you find yourself unable to meet an in-course requirement because of illness or compassionate reasons please advise the course instructor (or designated person, such as a teaching assistant) in writing, with your name, id#, and e-mail contact. The grounds for Academic Consideration are detailed in the Undergraduate and Graduate Calendars.

Undergraduate Calendar - Academic Consideration and Appeals

<https://www.uoguelph.ca/registrar/calendars/undergraduate/current/c08/c08-ac.shtml>

Graduate Calendar - Grounds for Academic Consideration

<https://www.uoguelph.ca/registrar/calendars/graduate/current/genreg/index.shtml>

Associate Diploma Calendar - Academic Consideration, Appeals and Petitions

<https://www.uoguelph.ca/registrar/calendars/diploma/current/index.shtml>

### 9.3 Drop Date

Students will have until the last day of classes to drop courses without academic penalty. The deadline to drop two-semester courses will be the last day of classes in the second semester. This applies to all students (undergraduate, graduate and diploma) except for Doctor of Veterinary Medicine and Associate Diploma in Veterinary Technology (conventional and alternative delivery) students. The regulations and procedures for course registration are available in their respective Academic Calendars.

Undergraduate Calendar - Dropping Courses

<https://www.uoguelph.ca/registrar/calendars/undergraduate/current/c08/c08-drop.shtml>

Graduate Calendar - Registration Changes

<https://www.uoguelph.ca/registrar/calendars/graduate/current/genreg/genreg-reg-regchg.shtml>

Associate Diploma Calendar - Dropping Courses

<https://www.uoguelph.ca/registrar/calendars/diploma/current/c08/c08-drop.shtml>

### 9.4 Copies of Out-of-class Assignments

Keep paper and/or other reliable back-up copies of all out-of-class assignments: you may be asked to resubmit work at any time.

### 9.5 Accessibility

The University promotes the full participation of students who experience disabilities in their academic programs. To that end, the provision of academic accommodation is a shared responsibility between the University and the student.

When accommodations are needed, the student is required to first register with Student Accessibility Services (SAS). Documentation to substantiate the existence of a disability is required; however, interim accommodations may be possible while that process is underway.

Accommodations are available for both permanent and temporary disabilities. It should be noted that common illnesses such as a cold or the flu do not constitute a disability.

Use of the SAS Exam Centre requires students to book their exams at least 7 days in advance and not later than the 40th Class Day.

For Guelph students, information can be found on the SAS website

<https://www.uoguelph.ca/sas>

For Ridgetown students, information can be found on the Ridgetown SAS website  
<https://www.ridgetownc.com/services/accessibilityservices.cfm>

## 9.6 Academic Integrity

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 encourages academic integrity. 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 or faculty advisor.

Undergraduate Calendar - Academic Misconduct

<https://www.uoguelph.ca/registrar/calendars/undergraduate/current/c08/c08-amisconduct.shtml>

Graduate Calendar - Academic Misconduct

<https://www.uoguelph.ca/registrar/calendars/graduate/current/genreg/index.shtml>

## 9.7 Recording of Materials

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

## 9.8 Resources

The Academic Calendars are the source of information about the University of Guelph's procedures, policies, and regulations that apply to undergraduate, graduate, and diploma programs.

Academic Calendars

<https://www.uoguelph.ca/academics/calendars>