

# ENGG\*3260 Thermodynamics

**01**

Fall 2022

Section(s) C01

**Approved**

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**OUTLINE****ACTIVITY LOG****PROPERTIES**

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# ENGG\*3260 Thermodynamics

**01**

Fall 2022

Section(s): C01

School of Engineering

Credit Weight: 0.50

Version 1.00 - September 7, 2022

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## 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 Course Description

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, refrigeration, 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 and Second Laws of thermodynamics. In the analysis of power generation cycles, students are expected to formulate appropriate idealized thermodynamic process models and determine cycle efficiency. In the analysis of refrigeration and air conditioning systems, the students are expected to analyze the vapor compression cycle based on first and second law of thermodynamics and determine the cycle coefficient of performance.

### 1.3 Timetable

#### Lectures:

Sec. #	Day	Time	Location	Instructor
01	Mon, Wed, Fri	1:30 – 2:20 PM	RICH 2529	Dr. Elsharqawy & Dr. Tasnim
02	Mon, Wed, Fri	11:30 – 12:20 PM	RICH 2529	Dr. Elsharqawy & Dr. Tasnim

#### Tutorials/Labs:

Sec. #	Day	Time	Location	Teaching Assistant
101/201	Wednesday	3:30 – 5:20 PM	THRN 3402/4	Abrar Alzaydi
102/202	Monday	9:30 – 11:20 AM	THRN 3402/4	Kasra Ghasemi
103/203	Friday	3:30 – 5:20 PM	THRN 3402/4	Salman Soltanian
104/204	Wednesday	9:30 – 11:20 AM	THRN 3402/4	Debarshi Nath
105/205	Friday	9:30 – 11:20 AM	THRN 3402/4	Shahriyar Holagh
106/206	Tuesday	11:30 – 1:20 PM	THRN 3402/4	Albert Jiang

### 1.4 Final Exam

Wednesday, 7<sup>th</sup> December 2022. Time: 8:30 am – 10:30 am, online on CourseLink

## 2 Instructional Support

### 2.1 Instructional Support Team

<b>Instructor:</b>	Mostafa Elsharqawy
<b>Email:</b>	melsharq@uoguelph.ca
<b>Telephone:</b>	+1-519-824-4120 x54013
<b>Office:</b>	RICH 3513
<b>Instructor:</b>	Syeda Tasnim
<b>Email:</b>	stasnim@uoguelph.ca
<b>Telephone:</b>	+1-519-824-4120 x54013
<b>Office:</b>	THRN 2413

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

## 2.2 Teaching Assistants

### Abrar Alzaydi

**Email:** alzaydia@uoguelph.ca  
**Office Hours:** Wednesday 5:30 PM in room THRN 1425.  
Note: All emails related to tutorials/labs/exams should be sent to the **TA of your section**.

### Debarshi Nath

**Email:** debarshi@uoguelph.ca  
**Office Hours:** Tuesday 4:00 PM in room THRN 1425.  
Note: All emails related to tutorials/labs/exams should be sent to the **TA of your section**.

### Shahriyar Ghazanfari Holagh

**Email:** ghazanfs@uoguelph.ca  
**Office Hours:** Wednesday 12:30 PM in room THRN 1425.  
Note: All emails related to tutorials/labs/exams should be sent to the **TA of your section**.

### Salman Soltanian

**Email:** ssoltani@uoguelph.ca  
**Office Hours:** Friday 2:30 PM in room THRN 1425.  
Note: All emails related to tutorials/labs/exams should be sent to the **TA of your section**.

### Kasra Ghasemi

**Email:** kghasemi@uoguelph.ca  
**Office Hours:** Monday 12:30 PM in room THRN 1425.  
Note: All emails related to tutorials/labs/exams should be sent to the **TA of your section**.

### Albert Jiang

**Email:** zjiang@uoguelph.ca  
**Office Hours:** Tuesday 10:30 AM in room THRN 1425.  
Note: All emails related to tutorials/labs/exams should be sent to the **TA of your section**.

## 3 Learning Resources

### 3.1 Required Resources

#### Course Website (Website)

<https://courselink.uoguelph.ca/d2l/home/635871> (<https://courselink.uoguelph.ca/d2l/home/635871>)

Course material, news, announcements, and grades will be regularly posted to the ENGG\*3260 CourseLink website. You will be granted access to the website when you register for the course. You are responsible for checking the website regularly.

### 3.2 Recommended Resources

#### Thermodynamics–An Engineering Approach (Textbook)

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

### 3.3 Additional Resources

**Lecture Information:** Lecture notes will be posted on CourseLink throughout the semester.

**Lab Information:** The lab handouts will be available on CourseLink. The lab experiment will be explained by the TA during its scheduled week. Lab #1 will be a recorded video of the experiment and the experimental data will be provided on CourseLink. Labs 2 & 3 will be conducted in the lab. The TA and lab technician will help you to run the experiments.

**Assignments:** Download the assignments posted on CourseLink. These assignments are not graded; however, some of the assignment problems will be solved by the TA during the tutorials. Full assignment solutions will be posted on CourseLink as per the schedule.

**Miscellaneous Information:** Lectures are the main source of material which includes important discussions and worked examples that might not be found elsewhere. Other information related to this Thermodynamics course will be 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, refrigeration, 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 and Second Laws of thermodynamics. In the analysis of power generation cycles, students are expected to formulate appropriate idealized thermodynamic process models and determine cycle efficiency. In the analysis of refrigeration and air conditioning systems, the students are expected to analyze the vapor compression cycle based on first and second law of thermodynamics and determine the cycle coefficient of performance.

### 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. There will be no face to face lab work for Fall 2021. Lab demonstration videos will explain how to conduct a lab, what are the equipment and sensors needed, how to use them, how to collect data, how to analyze the results, etc.

8.

Write clear and concise laboratory reports for the labs.

9.

Demonstrate effective skills in teamwork during group activities (tutorials and group quizzes) 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
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

#	Outcome	Learning Outcome
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
7.1	Identify key message(s) and intended audience in verbal or written communication as both sender and receiver	8
7.2	Interpret technical documentation such as device specification sheets, drawings, diagrams, flowcharts, and pseudocode	8

## 5 Teaching and Learning Activities

### 5.1 Lecture Schedule

Week #	Lecture Topic	Reference	Learning Objectives
0	Introduction and course outline	Outline	1
1	Basic concepts, closed and open systems, equilibrium, pressure, and temperature	Chapter 1	1, 2
	Forms of energy, heat, work, mechanical forms of work, first law of thermodynamics, efficiency	Chapter 2	1, 2
2	Properties of pure substances, phase change, property diagrams and tables, ideal gas equation, equations of state	Chapter 3	1, 3
3	Energy analysis of closed systems, moving boundary work, energy balance, specific heats, internal energy, enthalpy	Chapter 4	1, 2, 3, 4
4, 5	1 <sup>st</sup> law control volumes, conservation of mass, flow work, Energy analysis of steady flow, SS devices, unsteady flow	Chapter 5	1, 2, 3, 4
6	Intro to 2 <sup>nd</sup> law of thermodynamics, Thermal reservoirs, heat engines, Refrigeration & heat pumps, perpetual motion machines, reversible and irreversible processes, Carnot cycle, Carnot principles, Carnot heat engine, Carnot heat pump	Chapter 6	3, 4, 5

7, 8	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
9	Vapor power cycles, Rankine cycle, Reheat Rankine cycle, Regenerative Rankine cycle	Chapter 10	3, 4, 5, 6
10	Refrigerators and heat pumps, revised Carnot cycle, Ideal and actual vapour-compression refrigeration cycles.	Chapter 11	3, 4, 5, 6
11	Gas power cycles, Carnot Cycle, Air standard assumptions, Otto cycle, Diesel cycle, Brayton cycle	Chapter 9	3, 4, 5, 6
12	Review	-	-

## 5.2 Tutorial/Lab Schedule

Week #	Tutorial Activity	Lab/ Quizzes
1	Assignment #1 problems	-
2	Assignment #2 problems	Quiz 1 (online)*
3	Assignment #3 problems	Quiz 2 (online)*
4	Assignment #4 problems	Quiz 3 (online)* and Lab 1**
5	Assignment #5 problems	-
6	Assignment #5 problems	Lab 2 (in-person)
7	Assignment #6 problems	-
8	Assignment #7 problems	Quiz 4 (in-person)
9	Assignment #8 problems	Quiz 5 (in-person)
10	Assignment #9 problems	Quiz 6 (in-person)
11	Assignment #10 problems	Lab 3 (in-person)
12	Assignment #10 problems	Quiz 7 (online)*

\* These quizzes will be online and can be taken any time during its scheduled week on CourseLink

\*\* This lab will be online using a recorded video of the experiment on CourseLink.

## 5.3 Important Dates

- Thursday, September 8, 2022: First day of classes
- Monday, October 10, 2022: Thanksgiving holiday (no classes)
- Tuesday, October 11, 2022: Fall break study day (no classes)
- Saturday, 22<sup>nd</sup> October 2022 at 12 pm, mid-term exam on CourseLink
- Wednesday, 7<sup>th</sup> December 2022 at 8:30 am, final exam on CourseLink



## 6 Assessments

### 6.1 Marking Schemes & Distributions

**Assignments: 0%**

Ten (10) unmarked assignments will be posted on CourseLink

**Online Quizzes: 15%**

Seven (7) online quizzes are scheduled in weeks 2, 3, 4, 8, 9, 10 and 12.

**Lab Reports: 15%**

Three (3) lab reports are scheduled in weeks 4, 6 and 11.

**Mid-term Exam: 35%**

The mid-term exam is scheduled on Saturday 22nd October 2022 at 12 pm, Online on CourseLink

**Final Exam: 35%**

Date: Wednesday 7th December 2022. Time: 8:30 AM – 10:30 AM. Online on CourseLink

Assessment	Weight (%)
Quiz 1	2.5
Quiz 2	2.5
Quiz 3	2.5
Quiz 4	2.5
Quiz 5	2.5
Quiz 6	2.5
Quiz 7	0
Lab Report 1	5
Lab Report 2	5
Lab Report 3	5
Midterm Exam	35
Final Exam	35
<b>Total</b>	<b>100</b>

### 6.2 Assessment Details

**Quiz 1 (2.5%)****When:** Week 2, online**Learning Outcomes:** 1**Quiz 2 (2.5%)****When:** Week 3, online**Learning Outcomes:** 2**Quiz 3 (2.5%)****When:** Week 4, online**Learning Outcomes:** 3**Quiz 4 (2.5%)****When:** Week 8, in-class**Learning Outcomes:** 5**Quiz 5 (2.5%)****When:** Week 9, in-class**Learning Outcomes:** 6**Quiz 6 (2.5%)****When:** Week 10, in-class**Learning Outcomes:** 6**Quiz 7 (0%)****When:** Week 12, Online**Learning Outcomes:** 6**Lab Report 1 (5%)****When:** Week 4, Online**Learning Outcomes:** 7, 9, 9

The Lab is scheduled in Week 4 and the report is due to Week 5.

**Lab Report 2 (5%)****When:** Week 6, Online**Learning Outcomes:** 7, 9, 9

The Lab is scheduled in Week 6 and the report is due to Week 7.

**Lab Report 3 (5%)****When:** Week 11, Online

**Learning Outcomes:** 7, 9, 9

The Lab is scheduled in Week 11 and the report is due to Week 12.

### Midterm Exam (35%)

**When:** Sat, Oct 23, 12:00 PM - 1:30 PM, Online

**Learning Outcomes:** 1, 2, 3, 4

### Final Exam (35%)

**When:** Wed, Dec 7, 8:30 AM - 10:30 AM, Online

**Learning Outcomes:** 4, 5, 6

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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 or quiz:** If you miss the mid-term or a quiz due to grounds for granting academic consideration, ***the weight of the missed test/quiz will be added to the final exam.*** There will be no makeup test or quiz

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

**Questions Concerning Grades:** If you have questions about the grade of your test received, please ask your GTA within one week of the grade being released.

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## 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.

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# 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 make a booking at least 14 days in advance, and no later than November 1 (fall), March 1 (winter) or July 1 (summer). Similarly, new or changed accommodations for online quizzes, tests and exams must be approved at least a week ahead of time.

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>

## 9.9 Disclaimer

Please note that the ongoing COVID-19 pandemic may necessitate a revision of the format of course offerings, changes in classroom protocols, and academic schedules. Any such changes will be announced via CourseLink and/or class email.

This includes on-campus scheduling during the semester, mid-terms and final examination schedules. All University-wide decisions will be posted on the COVID-19 website (<https://news.uoguelph.ca/2019-novel-coronavirus-information/>) and circulated by email.

## 9.10 Illness

Medical notes will not normally be required for singular instances of academic consideration, although students may be required to provide supporting documentation for multiple missed assessments or when involving a large part of a course (e.g.. final exam or major assignment).

## 9.11 Covid-19 Safety Protocols

For information on current safety protocols, follow these links:

- <https://news.uoguelph.ca/return-to-campuses/how-u-of-g-is-preparing-for-your-safe-return/>
- <https://news.uoguelph.ca/return-to-campuses/spaces/#ClassroomSpaces>

Please note, these guidelines may be updated as required in response to evolving University, Public Health or government directives.

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