

**Western University
Faculty of Engineering
Mechatronic Systems Engineering Program**

MSE 2214A—Thermodynamics

Course Outline 2020–21

Description: This course covers the fundamental laws of thermodynamics, evaluation of properties of pure substances (e.g. water, steam, ideal gases), and the application of these concepts to the study of thermodynamic systems such as pumps, turbines, compressors and their use in energy conversion systems.

Instructor: Dr. Christopher T. DeGroot, P.Eng.
SEB 3096, 519-661-2111 ext. 84455, cdegroo5@uwo.ca
Consultation hours: By appointment.

Academic Calendar Copy: Properties of a pure substance, first law of thermodynamics, processes in open and closed systems, second law of thermodynamics; ideal gases, compressors and energy conversion systems.

Contact Hours: 3 lecture hours, 0.5 laboratory hours, 2 tutorial hours, 0.5 course.

Antirequisite: CBE 2214A/B, MME 2204A/B.

Prerequisites: Applied Mathematics 1413.

Unless you have either the requisites for this course or written special permission from your Dean to enroll in it, you will be removed from this course and it will be deleted from your record. This decision may not be appealed. You will receive no adjustment to your fees in the event that you are dropped from a course for failing to have the necessary prerequisites.

CEAB Academic Units: Engineering Science 60%, Science 40%

Required Textbook: “Thermodynamics, An Engineering Approach”, 9th Edition. Yunus A. Cengel, Michael A. Boles; McGraw-Hill.

Required Software: None.

Recommended References: “Fundamentals of Engineering Thermodynamics,” 6th Edition, Copyright 2008; Michael J. Moran & Howard N. Shapiro, John Wiley & Sons Inc.

General Learning Objectives (CEAB Graduate Attributes):

Knowledge Base	D	Use of Engineering Tools		Impact on Society and the Environment	
Problem Analysis	D	Individual and Team Work		Ethics and Equity	
Investigation	I	Communication Skills		Economics and Project Management	

Design		Professionalism		Life-Long Learning	
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Notation: x represents the content level code as defined by the CEAB. blank = not applicable; I = introduced (introductory); D = developed (intermediate) and A = applied (advanced).

Topics and Specific Learning Objectives:

1. Introduction and definitions

At the end of this section, students will be able to:

- a. Understand and apply the definitions of work, energy, and heat
- b. Understand the concept of a thermodynamic system, be able to classify a system as closed, isolated, or open, and identify transfers of energy via work and heat

2. Properties of a pure substance

At the end of this section, students will be able to:

- a. Understand the concepts of thermodynamic state, equilibrium, simple compressible substances, and the state postulate
- b. Evaluate the thermodynamic properties of a pure substance in any phase, or combination of phases, using thermodynamic tables

3. First law of thermodynamics

At the end of this section, students will be able to:

- a. Apply first law of thermodynamics to closed and open systems and represent processes using property diagrams
- b. Derive simplified forms of the first law, starting from the general form, for common thermodynamic systems including pumps, compressors, turbines, etc.

4. Power and refrigeration cycles

At the end of this section, students will be able to:

- a. Analyze the operation of steam power cycles and refrigeration cycles
- b. Calculate the thermodynamic efficiencies of devices operating in a cycle and determine the maximum possible efficiency in the reversible limit

4. Second law of thermodynamics

At the end of this section, students will be able to:

- a. Understand the Clausius and Kelvin-Planck statements of the second law, and demonstrate their equivalency
- b. Understand the concepts of entropy, reversible processes, irreversibilities, and disorder in systems

5. Entropy changes of closed, open, reversible, and irreversible systems

At the end of this section, students will be able to:

- a. Evaluate the entropy change within closed, open, reversible, and irreversible systems undergoing a thermodynamic process
- b. Identify the entropy transfer associated with work and heat transfer

6. First and second law relationships and the universal principle of entropy increase

At the end of this section, students will be able to:

- a. Apply the first and second law to solve thermodynamics problems
- b. Understand the concept of entropy increase and its application to thermodynamic systems
- c. Determine whether or not processes are theoretically possible, based on second law analysis

Evaluation:

Course Component	Weight
Weekly Tutorial Exercises	10%
Participation	10%
Laboratory	10%
Midterm	25%
Final Examination	45%

Homework Assignments: Ungraded homework assignments containing suggested practice problems will be assigned on a weekly basis. Solutions will be provided the following week and will be discussed in tutorial.

Tutorial Exercises: Exercises will be assigned in most tutorial sessions for grading. Students may work in small groups assigned by the instructor. Students may also elect to work alone in the event that circumstances prevent them from collaborating with their peers (e.g. Internet connectivity issues). Students will have full access to their notes, textbooks, calculators, etc. A maximum of one hour will be given to complete the exercise. A maximum of 10 exercises will be assigned. Students will be allowed to drop their lowest 2 grades from the calculation of their overall tutorial exercise grade.

Participation: Students will be assigned a time slot during the scheduled lecture periods where they will be able to interact with the instructor and/or teaching assistants. A participation grade will be assigned based on attendance to these sessions as well as the level of student interaction.

Laboratory: There will be two lab exercises assigned. Lab demonstrations will be communicated by pre-recorded videos. Lab data will be sent to students for analysis. Calculations must be submitted for grading at the time designated by the instructor.

Midterm: There will be one midterm test. The midterms will be closed book. An equation aid and thermodynamics tables will be provided. Non-programmable calculators are permitted. Students are required to use the ProctorTrack software during the test. The tentative date and time of the midterm is October 27 during the tutorial period. This will be confirmed on the course OWL page in advance of this date.

Final Examination: The final examination will take place during the regular examination period and will be 3 hours in duration. The final exam will be closed book. An equation aid and thermodynamics tables will be provided. Non-programmable calculators are permitted. Students are required to use the ProctorTrack software during the test.

Course Policies: The following course-specific policies will be enforced throughout the course:

Computing requirements: All students are to ensure that they have a functional camera and microphone connected to their computer (irrespective of Windows or Mac-based). These two accessories will be required for all term tests, final exam, as well as when asking questions

during synchronous/live sessions or when working on in-tutorial assignments. The complete hardware specifications for Proctortrack-monitored tests are listed here:

<https://www.proctortrack.com/tech-requirements/>

Tutorial exercises: All tutorial exercises must be submitted the end of the designated writing period. No late submissions will be accepted. There are no make-up options regardless of the reason for which the exercise was missed. Of the maximum of 10 exercises, the lowest 2 grades will not be counted towards the student's grade.

Laboratory sessions: Submission of the laboratory exercises is mandatory to pass the course. All lab data and calculations must be handed in by the designated time for grading. Should a student neglect to submit their lab on time, a grade of zero may be given. The student still must complete the lab in order to be eligible to pass the course.

Midterm tests: No make-up midterm options will be offered, regardless of the circumstances for which the midterm test was missed. If a student misses a midterm test, the student must follow the Instructions for Students Unable to Write Tests and provide documentation to Undergraduate Services within 24 hours of the missed test. If a student is going to miss the midterm examination for religious reasons, they must inform the instructor in writing within 48 hours of the announcement of the exam date or they will be required to write the exam. Missing a midterm test with academic consideration will automatically shift the weight of the missed midterm test to the final exam. If no reasonable justification for missing a midterm test is provided, then the student will receive a grade of zero for the test.

Final examination: To obtain a passing grade in the course, a mark of 60% or more must be achieved on the final examination. A final examination mark < 60% will result in a final course grade of 48% or less. If the above conditions are not met, your final grade cannot be greater than 48%. Students who have failed this course (i.e., final average < 50%) must repeat all components of the course.

Exams/tests monitored by ProctorTrack: The primary intent is to use Proctortrack as the sole remote proctoring solution throughout the course. However, if certain temporary difficulties will prevent the use of Proctortrack, Zoom might be used as an alternative term test/exam invigilation tool. If Zoom will be used for term test/exam invigilation, you will be required to keep your camera on for the entire session, hold up your student card for identification purposes, and share your screen with the invigilator if asked to do so at any time during the exam. The exam session using Zoom will not be recorded. Proctortrack will require you to provide personal information (including some biometric data). The session will be recorded. By taking this course, you are consenting to the use of this software. More information about remote proctoring is available in the Online Proctoring Guidelines at the following link:

<https://www.uwo.ca/univsec/pdf/onlineproctorguidelines.pdf>.

Completion of this course will require you to have a reliable internet connection and a device that meets the system and technical requirements for both Zoom and Proctortrack. Information about the system and technical requirements are available at the following links:

<https://www.proctortrack.com/tech-requirements>

<https://support.zoom.us/hc/en-us>

If, for any reason, an examination monitored by ProctorTrack software is interrupted, the student will be subject to an oral examination in place of the written exam. In the event of an interruption, the student is required to immediately notify the instructor. The oral exam will take place as soon as possible thereafter, once a connection is re-established.

Online Class Demeanor/Netiquette: Some components of this course will involve online interactions. To ensure the best experience for both yourself and your classmates, please abide the following rules:

- All live sessions will take place via Zoom meetings. The links to be accessed for each class will be distributed through OWL.
- You will be required to authenticate in the Zoom meeting with your Western credentials **only** (SSO authentication on the westernuniversity.zoom.us domain). In the event you attempt to authenticate in the Zoom meeting with different credentials, you will be removed from the online session without any warning.
- Ensure that your Zoom participant name matches the one from the official class roster. Failure to do so will mean that you will be removed from the online session without any warning.
- To minimize the background noise, please mute your microphone for the duration of class unless speaking. Only speak once invited to speak by the instructor. Failure to do so might result in your immediate removal from the meeting.
- Do not share your screen during the meeting unless asked by the instructor.

The course instructor will act as moderator of the online live session and will attempt to answer the questions received from Zoom meeting participants. In this regard, please consider the following:

- If you wish to speak during the live meeting, please use the “raise hand” feature in Zoom and wait for the instructor to nominate you to speak.
- Zoom keeps track of the order in which the “raise hand” feature was activated by each participant. Meeting participants will be asked to speak in the Zoom indicated order.
- Please remember to unmute your microphone and turn on your video camera (if turned off) before speaking.
- Please self-identify yourself at the beginning of your comment.
- Please remember to mute your microphone after speaking (unless directed otherwise).
- Please put down your “virtual hand” after speaking.

Some general considerations pertaining to “netiquette”:

- Be courteous with all Zoom meeting participants.
- Be professional in all online postings and questions.
- Please note that disruptive behavior of any type to occur during online classes (including inappropriate use of the chat function) is unacceptable.
- Students found guilty of “Zoom-bombing” a class or of other serious online offenses may be subject to disciplinary measures covered by the Code of Student Conduct.

Use of English: In accordance with Senate and Faculty Policy, students may be penalized up to 10% of the marks on all assignments, tests, and examinations for improper use of English. Additionally, poorly written work with the exception of the final examination may be returned without grading. If resubmission of the work is permitted, it may be graded with marks deducted for poor English and/or late submission.

Attendance: All scheduled components of the course are mandatory unless otherwise stated. Any student who, in the opinion of the instructor, is absent too frequently from virtual meetings will be reported to the Dean (after due warning has been given). On the recommendation of the program, and with the permission of the Dean, the student will be debarred from taking the regular final examination in the course.

Absence Due to Illness or Other Circumstances: Students with disabilities work with Accessible Education (formerly SSD) which provides recommendations for accommodation based on medical documentation or psychological and cognitive testing. The accommodation policy can be found here: [Academic Accommodation for Students with Disabilities](#).

Academic Consideration for Student Absence: Students will have up to two (2) opportunities during the regular academic year to use an on-line portal to self-report an absence during the term, provided the following conditions are met: the absence is no more than 48 hours in duration, and the assessment for which consideration is being sought is worth 30% or less of the student's final grade. Students are expected to contact their instructors within 24 hours of the end of the period of the self-reported absence, unless noted on the syllabus. Students are not able to use the self-reporting option in the following circumstances:

- for exams scheduled by the Office of the Registrar (e.g., December and April exams)
- absence of a duration greater than 48 hours,
- assessments worth more than 30% of the student's final grade,
- if a student has already used the self-reporting portal twice during the academic year

If the conditions for a Self-Reported Absence are *not* met, students will need to provide a Student Medical Certificate if the absence is medical, or provide appropriate documentation if there are compassionate grounds for the absence in question. Students are encouraged to contact their Faculty academic counselling office to obtain more information about the relevant documentation.

Students should also note that individual instructors are not permitted to receive documentation directly from a student, whether in support of an application for consideration on medical grounds, or for other reasons. **All documentation required for absences that are not covered by the Self-Reported Absence Policy must be submitted to the Academic Counselling office of a student's Home Faculty.**

For Western University policy on Consideration for Student Absence, see [Policy on Academic Consideration for Student Absences - Undergraduate Students in First Entry Programs](#)

and for the Student Medical Certificate (SMC), see:

http://www.uwo.ca/univsec/pdf/academic_policies/appeals/medicalform.pdf.

Religious Accommodation: Students should consult the University's list of recognized religious holidays, and should give reasonable notice in writing, prior to the holiday, to the

Instructor and an Academic Counsellor if their course requirements will be affected by a religious observance. Additional information is given in the [Western Multicultural Calendar](#).

Cheating and Plagiarism: Students must write their essays and assignments in their own words. Whenever students take an idea or a passage from another author, they must acknowledge their debt both by using quotation marks where appropriate and by proper referencing such as footnotes or citations. University policy states that cheating, including plagiarism, is a scholastic offence. The commission of a scholastic offence is attended by academic penalties, which might include expulsion from the program. If you are caught cheating, there will be no second warning.

All required papers may be subject to submission for textual similarity review to commercial plagiarism-detection software under license to the University for the detection of plagiarism. All papers submitted will be included as source documents on the reference database for the purpose of detecting plagiarism of papers subsequently submitted to the system. Use of the service is subject to the licensing agreement, currently between the University of Western Ontario and Turnitin.com (<http://www.turnitin.com>).

Scholastic offences are taken seriously and students are directed to read the appropriate policy, specifically, the definition of what constitutes a Scholastic Offence, in the relevant section of the Academic Handbook:

http://www.uwo.ca/univsec/pdf/academic_policies/appeals/scholastic_discipline_undergrad.pdf

Use of Electronic Devices: Turn off all sound for pagers and cell phones. Students may use laptops, tablet computers, or smart phones *only* to access the course OWL site during lectures and tutorials. Use of *nonprogrammable* calculators *only* is permitted during quizzes and examinations. No other electronic devices may be used at any time during lectures, tutorials, or examinations.

Policy on Repeating All Components of a Course: Students who are required to repeat an Engineering course must repeat all components of the course. No special permissions will be granted enabling a student to retain laboratory, assignment, or test marks from previous years. Previously completed assignments and laboratories cannot be resubmitted by the student for grading in subsequent years.

Internet and Electronic Mail: Students are responsible for regularly checking their Western e-mail and the course web site (<https://owl.uwo.ca/portal/>) and making themselves aware of any information that is posted about the course. If the student fails to act on information that has been posted on these sites and does so without a legitimate explanation (i.e., those covered under the illness/compassionate form), then there are NO grounds for an appeal.

Accessibility: Please contact the course instructor if you require material in an alternate format or if any other arrangements can make this course more accessible to you. You may also wish to contact Services for Students with Disabilities (SSD) at 519-661-2111 ext. 82147 for any specific question regarding an accommodation.

Support Services: Office of the Registrar, <http://www.registrar.uwo.ca/>

Student Development Centre, <http://www.sdc.uwo.ca/>
Engineering Undergraduate Services, <http://www.eng.uwo.ca/undergraduate/>
USC Student Support Services, <http://westernusc.ca/services/>

Students who are in emotional/mental distress should refer to Mental Health @ Western, http://www.health.uwo.ca/mental_health/, for a complete list of options about how to obtain help.