

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

MSE 2214A—Thermodynamics

Course Outline 2023–24

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.

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 (2 in-person; 1 asynchronous), 0.5 laboratory hours (2 lab sessions x 3 hours), 2 tutorial hours (2 hours weekly), 0.5 course.

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

Prerequisites: NMM 1412A/B or the former Applied Mathematics 1412A/B.

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”, 10th Edition. Yunus A. Cengel, Michael A. Boles, Mehmet Kanoglu; McGraw-Hill. (*see course website for link to details*)

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	

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 any 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

CEAB GA Indicators: KB3 (Term Tests)

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 substances in any phase, or combination of phases, using thermodynamic tables

CEAB GA Indicators: I1, I2 (Compression and Marcet Boiler Labs)

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.

CEAB GA Indicators: KB4, PA1, PA2 (Term Tests)

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

CEAB GA Indicators: KB4, PA1, PA2, IESE2 (Final Exam)

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

CEAB GA Indicators: KB4 (Final Exam)

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

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

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

CEAB GA Indicators: KB4 (Final Exam)

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

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

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

CEAB GA Indicators: KB4 (Final Exam)

Evaluation:

Course Component	Weight
Weekly Tutorial Exercises	10%
Laboratory	10%
Term Test #1 (Oct. 5 (10:30am-12:30pm))	15%
Term Test #2 (Nov. 9 (10:30am-12:30pm))	15%
Final Examination	50%

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

Tutorial Exercises: Exercises will be assigned in most tutorial sessions for grading. Students may work in small groups of up to 3 students. Students will have full access to their notes, textbooks, calculators, etc. A maximum of one hour will be given to complete the exercise, including time to submit their work to Gradescope. A maximum of 8 exercises will be assigned. Students will be allowed to drop their lowest grade from the calculation of their overall tutorial exercise grade.

Laboratory: There will be two lab exercises assigned. All lab data and calculations must be submitted by the end of the laboratory period for grading.

Term Tests: There will be two term tests. The tests will be closed book. An equation aid and thermodynamics tables will be provided. Non-programmable calculators are permitted. The tests are tentatively set to be held on October 5, 2023 and November 9, 2023. Both will be held from 10:30 am to 12:30 pm (corresponding with the tutorial period).

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.

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

Computing requirements: All students are recommended to have a functional camera and microphone connected to their computer (irrespective of Windows or Mac-based). While the course is planned to be held in-person, virtual participation may be required based on extenuating circumstances.

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 grade will not be counted towards the student's grade.

Laboratory sessions: Attendance to laboratory sessions is mandatory. All pre-lab exercises must be completed prior to attending the lab in order to receive full grades. All lab data and calculations must be handed in by the end of the laboratory period for grading. Should a student miss a lab without legitimate reason, a grade of zero will be given and no opportunity to complete the lab at a later date will be provided.

Term tests: No make-up options will be offered for term tests, regardless of the circumstances for which the term test was missed. If a student misses a term 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 term test 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 test with academic consideration will automatically shift the weight of the missed test to the final exam. If no reasonable justification for missing a test is provided, then the student will receive a grade of zero for the test.

Final exam: To obtain a passing grade in the course, a mark of 50% or more must be achieved on the final examination. A final examination mark < 50% 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.

STATEMENT ON GENDER-BASED AND SEXUAL VIOLENCE

Western [is committed to reducing incidents of gender-based and sexual violence](#) and providing compassionate support to anyone who has gone through these traumatic events. If you have experienced gender-based or sexual violence (either recently or in the past), you will find information about support services for survivors, including emergency contacts, [here](#). To connect with a case manager or set up an appointment, please contact support@uwo.ca.

**INSTRUCTIONS FOR STUDENTS UNABLE TO WRITE TESTS OR EXAMINATIONS OR SUBMIT
ASSIGNMENTS AS SCHEDULED**

If, on medical or compassionate grounds, you are unable to write term tests or final examinations or complete course work by the due date, you should follow the instructions listed below. You should understand that academic relief will not be granted automatically on request. You must demonstrate to your department (or the Undergraduate Services Office) that there are compelling medical or compassionate grounds that can be documented before academic relief will be considered. Different regulations apply to term tests, final examinations and late assignments. Please read the instructions carefully.

A. GENERAL REGULATIONS & PROCEDURES

1. All first-year students will report to the Undergraduate Services Office by submitting the [Academic Consideration Request Form](#), for all instances.
2. If you are an upper year student and you are missing a test/assignment/lab or examination you will report the absence by submitting [Academic Consideration Request Form](#). Absences worth LESS THAN 10% of your mark, will be processed by your department office. If your course work is worth 10% OR MORE of your final grade, your request will be processed by the Undergraduate Services Office.
3. Check the course outline to see if the instructor has a policy for missed tests, examinations, late assignments or attendance.
4. Documentation must be provided as soon as possible. If no one is available in your department office or the Undergraduate Services Office, leave a message clearly stating your name & student number and reason for your call. The department telephone numbers are given at the end of these instructions.
5. If you decide to write a test or an examination you should be prepared to accept the mark you earn. Rewriting tests or examinations or having the value of a test or examination reweighted on a retroactive basis is not permitted.

B. TERM/MIDTERM TESTS

1. If you are in first year and you are unable to write a midterm/term test, contact the Undergraduate Services Office, SEB 2097 PRIOR to the scheduled date of the test.
2. If you are an upper year student and you are unable to write a midterm/term test, inform your instructor PRIOR to the scheduled date of the test and request relief through the [Academic Consideration Request Form](#). If the instructor is not available, leave a message for him/her at the department office. If the test is worth LESS THAN 10% of your mark, your request for relief will be processed by your department office. If the test is worth MORE THAN 10% of your final grade your request for relief will be processed by the

Undergraduate Services Office.

3. Be prepared to attach supporting documentation to the Department Chair and/or the Undergraduate Services Office through the online form (see next page for information on documentation).
4. Discuss with the instructor if and when the test can be rescheduled. The approval of the Chair or the Undergraduate Services Office is required when rescheduling midterm/term tests.

C. **FINAL EXAMINATIONS**

1. If you are unable to write a final examination, contact the Undergraduate Services Office PRIOR TO THE SCHEDULED EXAMINATION TIME to report your absence using the [Academic Consideration Request Form](#) and request permission to write a Special Final Examination. If no one is available in the Undergraduate Services Office, leave a message clearly stating your name & student number.
2. Be prepared to provide the Undergraduate Services Office with supporting documentation (see next page for information on documentation) the next day, or as soon as possible (in cases where students are hospitalized). The following circumstances are not considered grounds for missing a final examination or requesting special examinations: common cold, headache, sleeping in, misreading timetable and travel arrangements.
3. In order to receive permission to write a Special Examination, you must obtain the approval of the Chair of the Department **and** the Associate Dean and in order to apply you must submit an "[Application for a Special Exam](#)" form. The Undergraduate Services Office will then notify the course instructor(s) and reschedule the examination on your behalf.

PLEASE NOTE: It is the student's responsibility to check the date, time and location of the Special Examination.

D. **LATE ASSIGNMENTS**

1. Advise the instructor if you are having problems completing the assignment on time (**prior** to the due date of the assignment).
2. Be prepared to submit the [Academic Consideration Request Form](#) and provide documentation if requested by the instructor (see reverse side for information on documentation).
3. If you are granted an extension, establish a due date. The approval of the Chair of your Department (or the Assistant Dean, First Year Studies, if you are in first year) is not required if assignments will be completed prior to the last day of classes.
4.
 - i) Extensions beyond the end of classes must have the consent of the instructor, the department Chair and the Associate Dean, Undergraduate Studies. Documentation is mandatory.
 - ii) A Recommendation of Incomplete Form must be filled out indicating the work to be completed and the date by which it is due. This form must be signed by the student, the instructor, the department Chair and the Associate Dean, Undergraduate Studies.

E. **SHORT ABSENCES**

If you miss a class due to a minor illness or other problem, check your course outlines for information regarding attendance requirements and make sure you are not missing a test, laboratory or assignment. Cover any readings and arrange to borrow notes from a classmate.

F. **EXTENDED ABSENCES**

If you are absent more than one week or if you get too far behind to catch up, you should consider reducing your workload by dropping one or more courses. (Note drop deadlines listed below). You are strongly encouraged to seek advice from your Academic Counsellor in the Undergraduate Services Office.

G. DOCUMENTATION

If you consulted an off-campus doctor or Student Health Services regarding your illness or personal problem, **you must provide the doctor with a Student Medical Certificate** to complete at the time of your visit and then bring it to the Department (or the Undergraduate Services Office). **This note must contain the following information: severity of illness, effect on academic studies and duration of absence. Regular doctor's notes will not be accepted; only the Student Medical Certificate will be accepted.**

In Case of Serious Illness of a Family Member: Provide a Student Medical Certificate to your family member's physician to complete and bring it to the Department (or the Undergraduate Services Office if you are in first year).

In Case of a Death: Obtain a copy of the death certificate or the notice provided by the funeral director's office. You must include your relationship to the deceased and bring it to the Department (or the Undergraduate Services Office if you are in first year).

For Other Extenuating Circumstances: If you are not sure what documentation to provide, ask the Departmental Office (or the Undergraduate Services Office if you are in first year) for direction.

Note: Forged notes and certificates will be dealt with severely. To submit a forged document is a scholastic offence (see below).

H. ACADEMIC CONCERNS

1. You need to know if your instructors have a policy on late penalties, missed tests, etc. This information may be included on the course outlines. If not, ask your instructor(s).
2. You should also be aware of attendance requirements in some courses. You can be debarred from writing the final examination if your attendance is not satisfactory.
3. If you are in academic difficulty, check out the minimum requirements for progression in the calendar. If in doubt, see your Academic Counsellor.

Calendar References: Check these regulations in your 2023 Western Academic Calendar available at www.westerncalendar.uwo.ca.

Absences Due to Illness:

https://www.westerncalendar.uwo.ca/PolicyPages.cfm?Command=showCategory&PolicyCategoryID=1&SelectedCalendar=Live&ArchiveID=#Page_135

Academic Accommodations for Students with Disabilities:

http://www.westerncalendar.uwo.ca/PolicyPages.cfm?Command=showCategory&PolicyCategoryID=1&SelectedCalendar=Live&ArchiveID=#Page_10

Academic Accommodations for Religious or Holy Days:

http://www.westerncalendar.uwo.ca/PolicyPages.cfm?Command=showCategory&PolicyCategoryID=1&SelectedCalendar=Live&ArchiveID=#Page_16

Course Withdrawals:

http://www.westerncalendar.uwo.ca/PolicyPages.cfm?Command=showCategory&PolicyCategoryID=6&SelectedCalendar=Live&ArchiveID=#Page_75

Examinations:

http://www.westerncalendar.uwo.ca/PolicyPages.cfm?PolicyCategoryID=5&command=showCategory&SelectedCalendar=Live&ArchiveID=#Page_75

Scheduling of Term Assignments:

http://www.westerncalendar.uwo.ca/PolicyPages.cfm?Command=showCategory&PolicyCategoryID=5&SelectedCalendar=Live&ArchiveID=#SubHeading_78

Scholastic Offences:

http://www.westerncalendar.uwo.ca/PolicyPages.cfm?Command=showCategory&PolicyCategoryID=1&SelectedCalendar=Live&ArchiveID=#Page_20

Student Medical Certificate:

<https://www.eng.uwo.ca/files/undergraduate/student-medical-certificate.pdf>

Engineering Academic Regulations:

http://www.westerncalendar.uwo.ca/PolicyPages.cfm?Command=showCategory&PolicyCategoryID=4&SelectedCalendar=Live&ArchiveID=#Page_86

Note: These instructions apply to all students registered in the Faculty of Engineering regardless of whether the courses are offered by the Faculty of Engineering or other faculties in the University.

Add Deadlines:

- September 15, 2023 First term half course (i.e. “A” or “F”)
- September 15, 2023 Full courses and full-year half course (i.e. “E”, “Y” or no suffix)
- January 16, 2024 Second term half course (i.e. “B” or “G”)

Drop Deadlines:

- November 13, 2023 First term half course without penalty (i.e. “A” or “F”)
- November 30, 2023 Full courses and full-year half courses without penalty (i.e. “E”, “Y” or no suffix)
- March 7, 2024 Second term half or second term full course without penalty (i.e. “B” or “G”)

Contact Information:

- Undergraduate Services Office: SEB 2097 Phone: 519-661-2130 E-mail: engugrad@uwo.ca
- Chemical & Green Process Engineering: TEB 477 Phone: 519-661-2131 E-mail: cbeugrad@uwo.ca
- Civil Engineering: SEB 3005 Phone: 519-661-2139
E-mail: civil@uwo.ca
- Computer, Electrical, Mechatronic Systems & Software Engineering TEB 279 Phone: 519-661-3758 E-mail: eceugrad@uwo.ca
- Integrated Engineering ACEB 2410 Phone: 519-661-6725
E-mail: engceli@uwo.ca
- Mechanical Engineering: SEB 3002 Phone: 519-661-4122 E-mail: mmeundergraduate@uwo.ca