Faculty of Engineering
CBE 2214A – Engineering Thermodynamics
Course Outline 2025-2026

Description

Engineering thermodynamics deals with the macroscopic relationships between thermal energy (and its transfer, referred to as heat) and work (useful energy) at steady-state and in uniform systems. The interconversion of thermal energy and work materialized in heat engines, power plants, internal combustion engines, diesel engines, jet engines, and in the refrigeration and air-conditioning units. The properties of the working fluid (water-steam, refrigerant in vapor and liquid forms, and gas phase in jet engines and gas turbines) will be studied. The first and second laws of thermodynamics will be covered in detail. The concepts of enthalpy and entropy in closed and open systems and in thermodynamic cycles will be described.
At the end of this course, students will be able to analyze and design individual units such as pumps, compressors, steam and gas turbines, heat pumps, heat exchangers, nozzles, electric motors, etc., and thermodynamic cycles such as a heat engine or a refrigeration cycle, using hand calculations.

Learning Objectives

- Learn various forms of energy (potential energy; kinetic energy; internal energy – thermal energy, chemical energy, and nuclear energy; flow energy; various forms of work – shaft work, electrical and electromagnetic work, displacement work, etc.; and thermal energy transfer (heat transfer).
- Distinguish between a Closed and an Open system, and the Boundary of such systems with their Surroundings.
- Identify the Working Fluid (water, gas, refrigerant, gasoline, natural gas, etc.) of a given system.
- Understand various forms of energy that can be interconverted (First Law of Thermodynamics). (**KB1)**
- Learn how to write steady-state and non-steady-state mass and energy balance on closed and open systems. (**KB2)**
- Make the necessary assumptions, determine if the system is open or closed, or a cycle (**PA1**).
- Sketch the necessary diagrams to represent the operation/process from the initial state to the final state (**PA1**).
- Learn how to convert thermal energy to useful work (Heat Engines, Power Cycles, Internal Combustion Engines, Diesel Engines, Jet Engines) (**PA2**).
- Design various open and closed devices such as a pump, compressor, turbine, heat exchanger, a mixing tank, a piston and a cylinder (**DE1**).
- Grasp the idea of efficiency of a device and a thermodynamic cycle (Second Law of Thermodynamics and the concept of Entropy) and extend the concept to open-ended complex engineering problems (**DE2**).

Alignment with Faculty Wide Indicators: KB1 & KB2 **Level: Introductory**

Objective	Unacceptable	Below expectations	Meets expectations	Exceeds expectations
Demonstrate competence in engineering fundamentals and specialized engineering knowledge appropriate to engineering discipline. **KB1, KB2**	Less than 40% on Engineering Sciences midterm and final examination questions testing Knowledge Base. (Unable to recollect engineering fundamentals and specialized discipline-specific engineering knowledge)	40% to 59% on Engineering Sciences midterm and final examination questions testing Knowledge Base. (Recollection of engineering fundamentals and specialized discipline-specific engineering knowledge is inaccurate – fundamentals clearly wrong.)	60% to 84% on Engineering Sciences midterm and final examination questions testing Knowledge Base. (Competent in the essential aspects of engineering fundamentals and discipline specific engineering knowledge).	85% to 100% on Engineering Sciences midterm and final examination questions testing Knowledge Base. (Meets expectations plus: Recognizes nuances of engineering fundamentals and discipline – specific engineering knowledge – able to critically evaluate current academic literature in this light).

Alignment with Faculty Wide Indicators: PA1& PA2 Level: Introductory

Objective	Unacceptable	Below expectations	Meets expectations	Exceeds expectations
Demonstrate ability to solve the problem successfully, **PA1, PA2**.	No solution.	Solution is incomplete OR yields incorrect result.	Solution is complete AND essentially correct.	Meets expectations, plus: Presentation of solution envisaged in the context of its subsequent use.

Alignment with Faculty Wide Indicators: DE1& DE2 Level: Introductory

Objective	Unacceptable	Below expectations	Meets expectations	Exceeds expectations
Demonstrate ability to frame a complex, open-ended design problem in engineering terms, **DE1, DE2**.	No solution.	Solution is incomplete OR yields incorrect result.	Solution is complete AND essentially correct.	Meets expectations, plus: Presentation of solution envisaged in the context of its subsequent use.

Prerequisites
Applied Mathematics 1411
Unless you have either the requisites for this course or written special permission from your Course Instructor 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.

Antirequisite
MME 2204A/B.

Contact Hours
3 lecture hours per week, 2 tutorial hours per week including a possible tour of the UWO Campus Power Plant, 0.5 course.

Instructor
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Teaching Assistants

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Recommended Text

"Thermodynamics, An Engineering Approach", Yunas A. Cengel, Michael A. Boles, McGraw Hill, 7th, 8th or higher editions.

Topics

Chapter 0: A general introduction to the course content and the engineering applications based on the principles of thermodynamics
Chapter 1: Introduction – basic concepts, systems and surroundings, properties of a system, a cycle, pressure and temperature
Chapter 2: Energy, heat, work, different forms of work, the first law of thermodynamics, heat engine efficiency, combustion efficiency, generator efficiency, motor efficiency, etc.
Chapter 3: Properties of pure substances, steam tables, quality index of water-steam mixture, ideal gas, compressibility factor, other equations of state
Chapter 4: Energy and mass analysis of closed systems, the first law of thermodynamics, the polytropic process
Chapter 5: Energy and mass analysis of open systems (control volumes), steady state, steady flow systems, nozzles and diffusers, turbines, compressors and fans, throttling devices, mixing chambers, heat exchangers, pumps
Chapter 6: The second law of thermodynamics, heat engines, heat pumps, coefficient of performance, Kelvin-Plank statement of the second law, Clausius statement of the second law, the Carnot cycle, reverse Carnot cycle, Carnot efficiency
Chapter 7: Entropy, the Clausius inequality, isentropic process, entropy balance.
Chapter 9: Gas power cycles, Carnot cycle, Otto cycle, diesel cycle
Chapter 10: Steam power cycles, limitations of the Carnot vapor cycle, the Rankine cycle, the reheat cycle
Chapter 11: Vapor compression refrigeration cycle, heat pump systems
Chapter 12: Thermodynamic property relations, Maxwell relations, reciprocity and the cyclic relations, Clapeyron equation, Clapeyron-Clausius equation, Joule-Thompson coefficient.

Specific Learning Objectives

- To develop a conceptual understanding of the fundamental elements of classical thermodynamics
- To be able to identify the thermodynamic state of a substance under any given condition
- To develop knowledge of different equations of state for predicting PVT properties of pure substances.
- To develop an understanding of closed and open systems and how to account for the transfer of energy via work and heat
- To develop knowledge of the 1st and 2nd laws of thermodynamics. The students will be taught how to set up and solve real engineering problems.

Evaluation

The final course mark will be determined as follows:

Weekly Assignments with solutions provided – you are responsible to go through the weekly assignments and their solution.

Four **announced** quizzes (closed book) during Class time or Tutorial time, **NO MAKEUP QUIZZEZ**, three out of four best marks, each worth 5 marks, will contribute to the final mark. The students who miss quizzes LEGITIMATELY, the corresponding marks of the missed quizzes will be added to the FINAL exam weight. **15%**

Midterm Exam (closed book) (two hours, date and time to be decided) **35%**

Final Examination (closed book) (three hours) **50 %**

Only **non-programmable pocket calculators** with purged memory will be permitted in the exams.

Completion of this course will require you to have a reliable internet connection and a device that meets the technical requirements for this service. Information about the technical requirements is available at the following link:

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

Note

1) Assignments are posted on OWL and must be handed in electronically on the specified due date provided by the instructor.

Academic considerations

In this course, your written assignments have a no-questions-asked 2-day grace period. This means that you can submit any of these assignments up to 2 days past the posted deadline without penalty. As such, requests for academic consideration for assignments will be denied.

Repeating All Components of the Course

In accordance with Senate and Faculty Policy, students who have failed an Engineering course (i.e., <50%) 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 for grading by the student in subsequent years.

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 the 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

Attendance in all lectures, tutorials and labs is mandatory. Any student who, in the opinion of the instructor, is absent too frequently from class or laboratory periods in any course, will be reported to the Dean (after due warning has been given). On the recommendation of the Department concerned, and with the permission of the Dean, the student will be debarred from taking the regular examination in the course.

Cheating
University policy states that cheating 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 (see Scholastic Offence Policy in the Western Academic Calendar).

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. Plagiarism is a major academic offence (see Scholastic Offence Policy in the Western Academic Calendar).

The University of Western Ontario has software for plagiarism checking. Students may be required to submit their work in electronic form for plagiarism checking.

Conduct
Students are expected to arrive at lectures on time, and to conduct themselves during class in a professional and respectful manner that is not disruptive to others.

STATEMENT ON GENDER-BASED AND SEXUAL VIOLENCE
Western is committed to working to end gender-based and sexual violence on campus and in our community 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 can connect with a case manager or set up an appointment (support@uwo.ca).

Sickness and Other Problems
Students should immediately consult with the instructor or Department Chair if they have any problems that could affect their performance in the course. Where appropriate, the problems should be documented. The student should seek advice from the Instructor or Department Chair regarding how best to deal with the problem. Failure to notify the Instructor or Department Chair immediately (or as soon as possible thereafter) will have a negative effect on any appeal.

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 661-2111 x 82147 for any specific question regarding an accommodation.

Notice
Students are responsible for regularly checking their Western email and notices posted on Sakai (Owl).

Consultation
Students are encouraged to discuss problems with their teaching assistants and/or instructor in tutorial sessions. Office hours will be arranged for the students to see the teaching assistants. Other individual consultation can be arranged by appointment with the instructor.

Accreditation (AU) Breakdown

Engineering Science 75%
Engineering Design 25%
Aug/2025