Faculty of Engineering
CBE 2214A – Engineering Thermodynamics
Course Outline 2018-2019

Description
Engineering thermodynamics deals with the macroscopic relationship between the 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 is materialized in heat engines, power plants, internal combustion engines, diesel engines, jet engines, and in the refrigeration units. The properties of the working fluid (water-steam, refrigerant in vapor and liquid forms, gas) will be studied. The first and the second laws of thermodynamics will be covered in detail. The concepts of enthalpy and entropy in the closed and open systems and in the thermodynamic cycles will be described. At the end of this course, students will be able to analyze and design thermodynamic cycles using hand calculations. In addition, students will be enabled to analyze and design individual components or devices such as pumps, compressors, heat pumps, heat exchangers, nozzles, electric motors, etc.

Prerequisites
Applied Mathematics 1411
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.

Antirequisite
MME 2204A/B.

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

Instructor
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Recommended Text
Laboratory
A tour of UWO Campus Power Plant, the boiler and chiller circuits, cooling towers, air compressors, and the diesel engine generators

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, turbine, 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, the Maxwell relations, the reciprocity and the cyclic relations, the Clapeyron equation, the Clapeyron-Clausius equation, the Joule-Thompson coefficient.
Chapter 14: Gas-vapor mixtures and air conditioning, dew point, relative humidity, absolute humidity, wet-bulb, and dry-bulb temperatures, the psychrometric chart

General Learning Objectives

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<th>A knowledge base for engineering</th>
<th>B</th>
<th>Individual and team work</th>
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<th>Economics and project management</th>
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<td>Problem analysis</td>
<td>I</td>
<td>Communication skills</td>
<td>I</td>
<td>Life-long learning</td>
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<td>Investigation</td>
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<td>Professionalism</td>
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<tr>
<td>Design</td>
<td>B</td>
<td>Impact of engineering on society and the environment</td>
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<td>Key: B: evaluated at introductory level I: evaluated at intermediate level A: evaluated at advanced level n.e.: not evaluated</td>
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<tr>
<td>Use of engineering tools</td>
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<td>Ethics and equity</td>
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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.
- To gain an understanding of the corollaries of 1st and 2nd laws of thermodynamics

Evaluation

The final course mark will be determined as follows:

Weekly Assignments (submit on Thursdays by 4:00 pm to C463 locker in TEB 4th floor) 10%

Two quizzes (one before Midterm, one after Midterm – dates will be announced) 10%

Mid-term test (two hours, Wednesday October 17, 7:00 to 9:00 pm – Room TBA, closed book, one formula sheet typed or hand-written on one side of a US letter size paper is allowed) 30%

Final Examination (closed book, one formula sheet typed or hand-written on both sides of a US letter size paper is allowed) 50%

Only non-programmable pocket calculators will be permitted in the exams.

Note

1) Students must pass the final examination to pass this course. Students who fail the final examination will be assigned 48% if the aggregate mark is higher than 50% or the aggregate mark.

2) Assignments are to be handed in to the CBE 2214A locker (#463) in TEB on the specified due date provided by the instructor.

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.

**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% (37.8 AUs)
Engineering Design 25% (12.6 AUs)