Carleton University
Department of Mechanical and Aerospace Engineering

MAAE 3400 Applied Thermodynamics

Section: A

Winter 2024

Weekly Lecture Times: WF 1005 - 1125

Calendar Description

Gas and vapour power cycles: reheat, regeneration, combined gas/vapour cycles, cogeneration. Heat pump and refrigeration cycles: vapour compression cycles, absorption refrigeration and gas refrigeration. Mixtures of perfect gases and vapours: psychometry and combustion. Principles of turbomachinery.

Includes: Experiential Learning Activity

Prerequisite(s): MATH 1005 and MAAE 2400.

Lectures three hours a week, problem analysis and laboratories three hours a week.

Instructor

Section A - Florin Saceleanu
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Section B - Sarah Brown
Email: sarahbrown3@cmail.carleton.ca

Instructor Office Hours

Please email your instructor to schedule an appointment. For assignment questions, please start by emailing your PA TAs for assistance.

TA

Cem Kalkan
Email: cemkalkan3@cmail.carleton.ca

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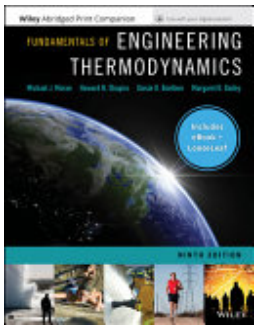
Required Texts



Title: Fundamentals of Engineering Thermodynamics, 9th Edition
Authors: Michael J. Moran, Howard N. Shapiro, Daisie D. Boettner, Margaret B. Bailey
Publisher: Wiley
Publication Date: 2018-01-17
Additional Information
A license for WileyPLUS electronic resources for Moran & Shapiro is also required for this course. If you purchased a multi-term WileyPLUS license when you took MAAE 2400 then you do not need to purchase another license.

If you need to purchase a license these are available at the Carleton Bookstore with or without a binder version of the book. Alternatively, students may purchase a WileyPLUS license directly from Wiley. Please contact Wiley for support as needed.

Course Schedule

Refer to the detailed course schedule posted on brightspace for all course deliverable and assessment dates.

Topic		# of lectures	Textbook Chapters
Review	Closed and open systems	2	1 - 6

	Evaluating thermodynamic properties		
	1st law of thermodynamics		
	2nd law of thermodynamics		
	Entropy		
Vapour Power Cycles	Carnot cycle	4	8
	Rankine cycle; reheat; regeneration		
	Binary cycles		
	Cogeneration		
Gas Power Cycles	Brayton cycle; regeneration; reheat; intercooling	4	9
	Otto, Diesel, Ericsson, and Stirling cycles		
	Combined cycle		
Refrigeration & Heat Pumps	Carnot cycle	3 + 1 online video	10
	Vapour compression cycles		
	Cascade and multi-stage cycles		
	Absorption cycles		
	Heat pumps		
	Brayton refrigeration cycles		
Mixtures and Psychrometrics	Analyzing properties of ideal gas mixtures	5	12
	Analyzing systems involving mixtures		
	Specific and relative humidity; dew point; adiabatic saturation		
	Wet-bulb and dry-bulb temperatures		
	Psychrometric charts		
	Application to air-conditioning processes and cooling towers		
Combustion	Chemical reactions	4 + 1 online video	13
	Stoichiometry and excess air		
	Enthalpy of formation		
	Enthalpy of combustion		
	Adiabatic flame temperature		
	Dissociation		

Lectures, PA, and Laboratory Sessions

Each week (except for Winter Break) there are two 1.5 hour lectures. Starting the week of January 15th, there will additionally be a weekly 3 hour problem analysis (PA)/lab session.

Attendance is mandatory for all lectures, PA, and lab sessions. Consult Carleton Central for the schedule and location of the lectures and PA sections for which you are registered (note that all laboratory experiments are conducted in ME 2230).

PA Sessions: The majority of the PA/lab sessions will be used for problem analysis tutorials. In these sessions, teaching assistants will guide students through solutions to typical problems. These PA sessions are critical to understanding and successfully applying the material covered in the lectures.

Laboratory Sessions: Three of the PA/lab sessions in the semester will be used to conduct laboratory experiments (all laboratory experiments will be conducted in ME 2230). Laboratories involve conducting experiments, taking measurements, analyzing data, and preparing reports. The mark for each laboratory experiment will be based on the lab reports, which must be submitted according to the schedule posted on Brightspace. Each student must produce their lab reports independently. All cases of suspected plagiarism will be reported to the Dean's office. Incomplete labs will result in a grade of FND in the course. Late report submission is not accepted and will result in a 0% mark for the lab experiment. Presentation requirements for the lab reports are described in the laboratory manual for the course. Students MUST familiarize themselves with the university's lab safety manual prior to conducting their first experiment.

Assignments

Graded problem sets will be assigned on a regular basis to reinforce the lecture material. These assignments will be completed and submitted online through WileyPLUS. They must be submitted before the due date and time posted on Brightspace. Late assignments will be given a grade of zero.

Midterms

Two midterms will be held during the scheduled lecture times (consult the detailed course schedule posted on brightspace for the exact midterm dates). These will be closedbook tests. Standard calculators can be used but no other electronic devices will be permitted. Carleton's Policy and Procedures for Writing Examinations will be in effect during these midterms. All cases of suspected plagiarism will be immediately reported to the Dean's office.

The midterms in this course are optional. If a student misses a midterm then the weight normally attributed to the missed midterm will be automatically transferred to the final exam in calculating the final course grade. Additionally, all final course grades will be calculated with and without existing midterm grades. If a higher final grade is achieved with the weight of one or more midterms moved to the final exam, this higher grade will be used instead. The purpose of this

policy is to encourage students to attempt the midterm for practice and as a way to self-assess understanding of course content throughout the semester.

Final Exam

The final exam will be scheduled by the university during the final exam period. This will be a closed-book examination. Standard calculators can be used but no other electronic devices are permitted.

Final Examination Policy

i) Final exams are for evaluation purpose and will not be returned to students.

ii) Students who are unable to write the final examination because of a serious illness/emergency or other circumstances beyond their control may apply for accommodation by contacting the Registrar's office. Consult Section 4.3 of the University Calendar: https://calendar.carleton.ca/undergrad/regulations/academicregulationsoftheuniversity/examinations/

Evaluation and Marking Scheme

Final Exam	50%
Midterms	20% (10% each)
Laboratories	15% (5% each)
Assignments	15%

A passing mark (50% and higher) is required on the final exam to obtain a passing grade in the course.

Midterms are optional (final grades will be calculated with and without existing midterm grades and the highest of these final grades for a particular student will be assigned to them at the end of term).

Active participation in all three lab experiments and a passing mark (50% and higher) is required in the laboratories to obtain a passing grade in the course.

Self-Declaration Form and Deferred Term Work

Contact the instructor with the completed self-declaration form no later than 3 days after the date/deadline of term work including test/midterm, labs, assignments.

Graduate Attributes and Accreditation

The Canadian Engineering Accreditation Board (CEAB) requires graduates of undergraduate engineering programs to possess 12 graduate attributes (GAs). Every course in our program impart some component of these attributes. In addition, the CEAB expects the content of every program to have certain minimum numbers of hours in various Curriculum Content categories. The CEAB Curriculum Content, Learning Objectives and GAs for this course are described in the following sections.

CEAB Curriculum Content

Math	Natural Science	Complementary Studies	Engineering Science	Engineering Design
			75%	25%

Learning Objectives

Learning Objective	Graduate Attribute (if applicable)
Apply fundamental knowledge of first and second law of thermodynamics, psychometrics and combustion theory in engineering.	GA1: Knowledge base
Apply thermodynamic principles to design and performance analysis of steam and gas turbines, as well as advanced power and refrigeration systems refrigeration cycles.	GA2: Problem analysis
Write technical/engineering reports based on experimental and theoretical analyses through laboratories, refrigeration/heat pumps, cooling towers, and heat value measurements, etc.	GA7: Communication skills

Graduate Attributes

Graduate Attribute	Taught at Level (Introductory, Developed, or Applied)	Assessed (yes/no)
GA1: Knowledge base	Developed	Yes
GA2: Problem analysis	Developed	No

Graduate Attribute	Taught at Level (Introductory, Developed, or Applied)	Assessed (yes/no)
GA4: Design	Developed	No
GA7: Communication skills	Developed	No

In addition, many courses evaluate students' progress towards acquiring the GAs. Aggregate data (typically, the data collected in all sections of a course during an academic year) is used for accreditation purposes and to guide improvements to our programs. Some of the assessments used to measure GAs may also contribute to final grades; however, the GA measurements for individual students are not used to determine the student's year-to-year progression through the program or eligibility to graduate. The following GA measurements are made in this course.

Evaluated GA Indicators

GA Indicator	Assessment Tool
1.9.M - Knowledge base: Discipline-specific concept MAE-6: Thermofluids	Final Exam Question

Academic Dates

Students should be aware of the academic dates (eg. last day for academic withdrawal) posted on the Registrar's office web site https://carleton.ca/registrar/registration/dates/academic-dates/

Academic Integrity and Plagiarism

a) Please consult the Faculty of Engineering and Design information page about the Academic Integrity policy and our procedures: https://carleton.ca/engineering-design/current-students/fed-academic-integrity Violations of the Academic Integrity Policy will result in the assignment of a penalty such as reduced grades, the assignment of an F in a course, a suspension or, expulsion.

b) One of the main objectives of the Academic Integrity Policy is to ensure that the work you submit is your own. As a result, it is important to write your own solutions when studying and preparing with other students and to avoid plagiarism in your submissions. The University Academic Integrity Policy defines plagiarism as “presenting, whether intentionally or not, the ideas, expression of ideas or work of others as one’s own.” This includes reproducing or paraphrasing portions of someone else’s published or unpublished material, regardless of the source, and presenting these as one’s own without proper citation or reference to the original source.

Examples of violations of the policy include, but are not limited to:

- Any submission prepared in whole or in part, by someone else;
- Using another's data or research findings without appropriate acknowledgement;
- Submitting a computer program developed in whole or in part by someone else, with or without modifications, as one's own; and
  failing to acknowledge sources of information through the use of proper citations when using another's work and/or failing to use quotations marks.
- Submitting text generated by AI tools as your own.
- Unauthorized assistance in midterm or final exams, including communications with others during the test, or accessing unauthorized materials (notes, books, websites, etc.) during the test.

Copyright

Academic Accommodation

Academic accommodation refers to educational practices, systems and support mechanisms designed to accommodate diversity and difference. The purpose of accommodation is to enable students to perform the essential requirements of their academic programs. At no time does academic accommodation undermine or compromise the learning objectives that are established by the academic authorities of the University.

Types of accommodation include those for recognized disabilities, pregnancy, religious obligation, survivors of sexual violence and student activities.

For disability accommodations, you must contact the Paul Menton Centre for Students with Disabilities (PMC) at 613-520-6608 or pmc@carleton.ca at the start of term, and you must also contact the PMC no later than two weeks before the first in-class scheduled test or exam requiring accommodation.

For other accommodations, please contact your instructor with any requests for academic accommodation during the first two weeks of class, or as soon as possible after the need for accommodation is known to exist.

Full details of the processes and resources for academic accommodation requests are available here.

Statement on Student Mental Health

As a University student you may experience a range of mental health challenges that significantly impact your academic success and overall well-being. Carleton's Wellness Services Navigator https://wellness.carleton.ca/navigator/ is designed to help students connect with mental health and wellness resources. If you need to talk to someone, please reach out for assistance: https://carleton.ca/health/emergencies-and-crisis/.

Statement on Equity, Diversity and Inclusion

Carleton University acknowledges the location of its campus on the traditional, unceded territories of the Algonquin nation. In doing so, Carleton acknowledges it has a responsibility to the Algonquin people. The Centre for Indigenous Support and Community Engagement at Carleton was created to support students, staff and faculty by providing culturally safe spaces for dialogue and learning. The Ojigkwanong Indigenous Student Centre is a place where First Nation, Métis and Inuit students can study, socialize, and participate in academic and cultural programming.