MAAE 3400
Applied Thermodynamics
Course Outline–Winter 2020

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.

Prerequisite: MAAE 2400.

Learning objectives

Knowledge Base (CEAB Graduate Attribute 1):

- Understanding the application of thermodynamic principles to the design and optimization of engineering systems.
- Ability to apply the 1st and 2nd laws of thermodynamics to vapour power cycles, gas power cycles, refrigeration and heat pump cycles, mixtures and psychrometrics, and combustion processes.

Problem Analysis (CEAB Graduate Attribute 2):

- Ability to make assumptions to solve engineering problems in thermodynamics.

Instructors

Section A
Professor Metin I. Yaras
Metin.Yaras@carleton.ca

Section B
Professor Reza Kholghy
Reza.Kholghy@carleton.ca

Section C
Professor Junjie Gu
Junjie Gu@carleton.ca

Reference material

- Fundamentals of Engineering Thermodynamics, 8th or 9th Edition, Moran & Shapiro (mandatory).
- License for WileyPLUS electronic resources for Moran & Shapiro (mandatory).
- Material posted on cuLearn.

The Moran & Shapiro textbook and WileyPLUS license are bundled together at the Carleton Bookstore:

- ISBN 9781119190868 for a hard cover book with the WileyPLUS license
- ISBN 9781119190981 for a binder version of the book with the WileyPLUS license.

Alternatively, students may purchase a WileyPLUS license directly from Wiley at http://www.campusebookstore.com/wiley/carleton/. This includes access to the electronic version of the book.

If you previously purchased a WileyPLUS license for MAAE 2400 you do not need to purchase another license. The system will remember you as a previous user when you click on any WileyPLUS link from within the MAAE 3400 cuLearn course. If you require any assistance with this, contact Wiley Technical Support by going to www.wileyplus.com/support.

Lectures, Laboratory sessions **and PA sessions**

Each week (except for Winter Break) there will be two one-and-a-half-hour lectures and one three-hour laboratory/problem analysis (PA) session. Attendance is mandatory for all lectures, lab sessions and PA sessions. Consult Carleton Central for the schedule and location of the lectures and PA sections for which you are registered. Information will be provided on the schedule and structure of the laboratory sessions during the first few weeks of lectures.

Practice Problems

Practice problems will be assigned through WileyPLUS on a regular basis to reinforce the lecture material.

Midterm exam

There will be one midterm exam: Saturday, February 29 from 12h00 to 14h00.

This will be a closed-book examination, although you may bring a two-side 8.5"x11" formula/notes sheet. Standard calculators can be used but no other electronic devices will be permitted.

Students who claim illness, injury, or other extraordinary circumstances beyond their control as a reason for missing a midterm exam must immediately inform the instructor and provide appropriate documentation. In such cases students will be given the option to write the missed midterm exam for practice and feedback, but no grades will be assigned; rather, the weight normally attributed to the missed midterm exam will be transferred to the final exam in calculating the final course grade.

Final exam

The final exam will be scheduled by the university during the final exam period. This will be a closed-book examination, although you may bring a two-side 8.5"x11" formula/notes sheet. Standard calculators can be used but no other electronic devices will be permitted.

Marking scheme

Midterm examination	25%
Laboratory Participation and Reports	15%
Final examination	60%

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

Active participation in all three lab experiments and a passing lab mark (50% or higher) based on the assessment of the lab reports for the three lab experiments is required to obtain a passing grade in the course. The mark for each laboratory experiment is based on a lab report that is to be submitted within seven (7) days of completing the laboratory experiment. The lab report is to be deposited as a digital copy in pdf format at a location to be designated by your course instructor. Each student is to produce his/her lab report individually. 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.

Course topics

	Topic	# lectures	Chapters
Review	• Closed and open systems • Evaluating thermodynamic properties • 1st law of thermodynamics • 2nd law of thermodynamics • Entropy	2	1-6
Vapour power cycles	• Carnot cycle • Rankine cycle; reheat; regeneration • Binary cycles • Cogeneration	4	8
Gas power cycles	• Brayton cycle; regeneration; reheat; intercooling • Otto, Diesel, Ericsson, and Stirling cycles • Combined cycle	4	9
Refrigeration & heat pumps	• Carnot cycle • Vapour compression cycles • Cascade and multi-stage cycles • Absorption cycles • Heat pumps • Brayton refrigeration cycles	4	10
Mixtures & psychrometrics	• Analyzing properties of ideal gas mixtures • 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	5	12
Combustion	• Chemical reactions • Stoichiometry and excess air • Enthalpy of formation • Enthalpy of combustion • Adiabatic flame temperature • Dissociation	4	13
Turbomachinery	• Choice of turbomachine type; axial and centrifugal machinery; specific speed parameter • Euler's turbine-pump equation • Velocity diagrams for axial turbines and axial compressors	2	n/a

Academic accommodation

You may need special arrangements to meet your academic obligations during the term. For an accommodation request the processes are as follows:

Pregnancy obligation: Write to me 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. For more details see http://carleton.ca/equity/wp-content/uploads/Student-Guide-to-Academic-Accommodation.pdf.

Religious obligation: Write to me 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. For more details see http://carleton.ca/equity/wp-content/uploads/Student-Guide-to-Academic-Accommodation.pdf.

Academic accommodations for students with disabilities: The Paul Menton Centre for Students with Disabilities (PMC) provides services to students with Learning Disabilities (LD), psychiatric/mental health disabilities, Attention Deficit Hyperactivity Disorder (ADHD), Autism Spectrum Disorders (ASD), chronic medical conditions, and impairments in mobility, hearing, and vision. If you have a disability requiring academic accommodations in this course, please contact PMC at 613-520-6608 or pmc@carleton.ca for a formal evaluation. If you are already registered with the PMC, contact your PMC coordinator to send me your Letter of Accommodation at the beginning of the term, and no later than two weeks before the first in-class scheduled test or exam requiring accommodation (if applicable). After requesting accommodation from PMC, meet with me to ensure accommodation arrangements are made. Please consult the PMC website for the deadline to request accommodations for the formally-scheduled exam (if applicable).