

# MAAE 3400

## Applied Thermodynamics

### Preliminary Course Outline–Winter 2018

#### 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 1<sup>st</sup> and 2<sup>nd</sup> 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.

#### Instructors

Section A	Section B
Professor Ian Beausoleil-Morrison Faculty of Engineering and Design Canal Building 6209 Ian_Beausoleil-Morrison@carleton.ca	Professor Metin Yaras Faculty of Engineering and Design Mackenzie Building 3254 Metin.Yaras@carleton.ca

## Reference material

- Fundamentals of Engineering Thermodynamics, 8th Ed, 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.campusbookstore.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](http://www.wileyplus.com/support) or the Wiley student partner, Marie Leunissen at [MarieLeunissen@cmail.carleton.ca](mailto:MarieLeunissen@cmail.carleton.ca).

## Lectures and PA sessions

Each week (except for Winter Break) there will be two one-and-a-half-hour lectures and one one-hour problem analysis (PA) session. Attendance is mandatory for all lectures and PA sessions. Consult Carleton Central for the schedule and location of the lectures and PA sections for which you are registered.

## Assignments

Problems will be assigned on a regular basis to reinforce the lecture material. These assignments and their due dates will be posted on cuLearn. Many assignments will be completed and submitted online through WileyPLUS (refer to reference material above). Some assignments may require handwritten solutions, which you will scan and submit via cuLearn.

Both types of assignments must be submitted before the due date and time posted on cuLearn. Late assignments will not be accepted and will be given a grade of zero.

Students must solve the problem assignments on their own. All cases of suspected plagiarism will be immediately reported to the Dean's office.

## Midterm exams

There will be two midterm exams:

1. Saturday, February 10 from 12h00 to 13h30.
2. Saturday, March 24 from 12h00 to 13h30.

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

## Marking scheme

Assignments	10%
Midterm exams	$2 \times 17.5\%$
Final exam	55%

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

## Course topics

	Topic	# lectures	Chapters
<i>Review</i>	<ul style="list-style-type: none"> <li>● Closed and open systems</li> <li>● Evaluating thermodynamic properties</li> <li>● 1<sup>st</sup> law of thermodynamics</li> <li>● 2<sup>nd</sup> law of thermodynamics</li> <li>● Entropy</li> </ul>	2	1-6
<i>Vapour power cycles</i>	<ul style="list-style-type: none"> <li>● Carnot cycle</li> <li>● Rankine cycle; reheat; regeneration</li> <li>● Binary cycles</li> <li>● Cogeneration</li> </ul>	4	8
<i>Gas power cycles</i>	<ul style="list-style-type: none"> <li>● Brayton cycle; regeneration; reheat; intercooling</li> <li>● Otto, Diesel, Ericsson, and Stirling cycles</li> <li>● Combined cycle</li> </ul>	4	9
<i>Refrigeration &amp; heat pumps</i>	<ul style="list-style-type: none"> <li>● Carnot cycle</li> <li>● Vapour compression cycles</li> <li>● Cascade and multi-stage cycles</li> <li>● Absorption cycles</li> <li>● Heat pumps</li> <li>● Brayton refrigeration cycles</li> </ul>	4	10
<i>Mixtures &amp; psychrometrics</i>	<ul style="list-style-type: none"> <li>● Analyzing properties of ideal gas mixtures</li> <li>● Analyzing systems involving mixtures</li> <li>● Specific and relative humidity; dew point; adiabatic saturation</li> <li>● Wet-bulb and dry-bulb temperatures</li> <li>● Psychrometric charts</li> <li>● Application to air-conditioning processes and cooling towers</li> </ul>	5	12
<i>Combustion</i>	<ul style="list-style-type: none"> <li>● Chemical reactions</li> <li>● Stoichiometry and excess air</li> <li>● Enthalpy of formation</li> <li>● Enthalpy of combustion</li> <li>● Adiabatic flame temperature</li> <li>● Dissociation</li> </ul>	4	13
<i>Turbomachinery</i>	<ul style="list-style-type: none"> <li>● Choice of turbomachine type; axial and centrifugal machinery; specific speed parameter</li> <li>● Euler’s turbine-pump equation</li> <li>● Velocity diagrams for axial turbines and axial compressors</li> </ul>	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](mailto: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).