



Faculty of Engineering
Department of Mechanical Engineering
COURSE OUTLINE

MECH 443 – Advanced Thermodynamics

Term – Spring 2016 (201601)

Course Web Site:	http://coursespaces.uvic.ca/course/view.php?id=10605
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Instructor	Office Hours
Dr. Henning Struchtrup	Days: Open door
Phone: 1-250-721-8916	Time: whenever I am in
E-mail: struchtr@uvic.ca	Location: EOW 511

Prerequisites and co-requisites: MECH 390, MECH 240, MATH 101, MATH 100
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LECTURE DATE(S)

Section: A /CRN 22216	Days: TWF	Time: 8:30 – 9:20	Location: ECS 108
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TUTORIAL AND LAB SECTIONS

This course has no tutorial, and no lab			
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TA Name	E-mail	Office
Alexander Beckmann	beckmann@uvic.ca	

Required Text	Optional Text
Title: Thermodynamics and Energy Conversion	
Author: Struchtrup, Henning	
Publisher/Year: Springer 2014. Download e-book or order printed version (needs UVic connection) http://link.springer.com/book/10.1007%2F978-3-662-43715-5	There is not a single other text that combines the material. Any other textbook can be used
Reference Materials: additional material might be posted on the website. We have a site license for http://www.thermofluids.net/ , which has lots of property data, problems, animations etc. For full access, you must be registered, and connect from a UVic computer (use UVic VPN from outside)	

COURSE OBJECTIVES:

This course extends the application of thermodynamics to inert and reacting mixtures, and further deepens the understanding of the laws of thermodynamics, and their application to engineering devices and processes. Principles of processes, and losses to irreversibilities are carefully examined.

Tentative outline (see webpage for more detail)

1. Thermodynamic potentials, Maxwell relations, measurement of properties (3 lectures)

2. Stability conditions, barometric formula, stability of atmosphere, (solar) chimney (4 lectures)
3. Phase equilibria, chemical potential, ideal mixtures, entropy and disorder (4 lectures)
4. Osmosis and reverse osmosis, reversible and irreversible mixing (2 lectures)
5. Gibbs phase rule, Raoult's law, phase diagram, distillation, etc (4 lectures)
6. Activity and fugacity (2 lectures)
7. Reacting mixtures, stoichiometric coefficients, law of mass action (4 lectures)
8. Enthalpy and entropy constants, third law (2 lectures)
9. Combustion, maximum work, entropy generation, losses in steam power plant (3 lectures)
10. Fuel cells, open circuit voltage, ohmic losses, efficiencies, mass transfer loss (3 lectures)
11. Activation of reaction, activation overpotential, exchange current (3 lectures)
12. Fuel cell types and design, fuel cell systems (3 lectures)

LEARNING OUTCOMES:

Students who successfully complete this course will be able to:

1. Properties and potentials—Evaluation of the Gibbs equation

Use Gibbs equation and multivariable calculus to identify thermodynamic potentials, find relations between thermodynamic properties and produce their own property tables.

2. Equilibrium conditions

Determine equilibrium states by maximizing/minimizing appropriate thermodynamic system properties.

3. Mixtures, Chemical potential

Formulate and apply mass balance, 1st law and 2nd law to inert and reacting mixtures.

Explain and determine mixing volume, heat of mixing, entropy of mixing, and the chemical potential.

4. Mixing and separation

Determine entropy generation and work loss in mixing.

Determine the work requirements in desalination, CO₂ sequestration and other separation processes; estimate contribution of irreversible processes.

Determine power available in controlled mixing, apply to osmotic power generation plants.

5. Phase equilibrium

Formulate and apply equilibrium conditions for ideal and non-ideal mixtures.

Draw phase diagrams.

Explain and evaluate phase diagrams for distillation processes and absorption refrigeration.

6. Reacting mixtures, law of mass action

Derive and apply the law of mass action; determine shift of equilibrium state with changing properties (Le Chatelier).

7. Activation of reactions

Use simplified mathematical models to explain metastable states, speed of reactions, and the need for catalysts.

8. Combustion

Use property tables and tables for enthalpy of formation to extract required property values.

Determine heat of reaction, heat exchange in combustion processes.

Explain the irreversible process nature of combustion and determine associated work losses.

9. Thermodynamics of Fuel Cells

Compare and contrast reaction processes in fuel cells with combustion.

Use thermodynamic laws to determine open circuit potential.

Use concepts of non-equilibrium thermodynamics to assess irreversible losses due to mass transfer, resistance and activation.

Analyse electrolyzers as inverse fuel cells.

Assess feasibility of hydrogen as a fuel in the hydrogen chain.

Weight & Date(s) of Assessments:	Weight	Date
Assignments:	40 %	10 assignments
Mid-term	20%	Date: TBA
Final Exam	40%	Date: TBA

ASSIGNMENTS

Assignments will be posted weekly, and will be due one week after posting. The assignments will be discussed in class when necessary. Use the office hours to ask questions whenever you have trouble with the solutions!

NOTE

Failure to pass the final exam will result in a failing grade for the course.
Midterm and Final are open book examinations. You need to bring the print-out of the posted property tables.

The final grade obtained from the above marking scheme for the purpose of GPA calculation will be based on the percentage-to-grade point conversion table as listed in the current Undergraduate Calendar.

COURSE LECTURE NOTES

Unless otherwise noted, all course materials supplied to students in this course have been prepared by the instructor (Dr. Struchtrup) and are intended for use in this course only. These materials are NOT to be re-circulated digitally, whether by email or by uploading or copying to websites, or to others not enrolled in this course. Violation of this policy may in some cases constitute a breach of academic integrity as defined in the UVic Calendar.

E GRADE

Assignment of E grade and supplemental examination for this course will be at the discretion of the Course Instructor. The rules for supplemental examinations can be found in the current Undergraduate Calendar.

COURSE SCHEDULE

See the course webpage for detailed schedule, and covered material.

<http://coursespaces.uvic.ca/course/view.php?id=10604>

GENERAL INFORMATION

Note to Students:

Students who have issues with the conduct of the course should discuss them with the instructor first. If these discussions do not resolve the issue, then students should feel free to contact the Chair of the Department by email or the Chair's Secretary to set up an appointment.

"Attendance"

Students are expected to attend all classes in which they are enrolled. An academic unit may require a student to withdraw from a course if the student is registered in another course that occurs at the same time....

An instructor may refuse a student admission to a lecture, laboratory, online course discussion or learning activity, tutorial or other learning activity set out in the course outline because of lateness, misconduct, inattention or failure to meet the responsibilities of the course set out in the course outline. Students who neglect their academic work may be assigned a final grade of N or debarred from final examinations.

Students who do not attend classes must not assume that they have been dropped from a course by an academic unit or an instructor. Courses that are not formally dropped will be given a failing grade, students may be required to withdraw and will be required to pay the tuition fee for the course." UVic Calendar, (2015) <http://web.uvic.ca/calendar2015-09/FACS/UnIn/UARe/Atte.html>

Accommodation of Religious Observance (AC1210)

<http://web.uvic.ca/calendar2015-09/GI/GUPo.html>

Discrimination and Harassment Policy (GV0205)

<http://web.uvic.ca/calendar2015-09/GI/GUPo.html>

Faculty of Engineering, University of Victoria Standards for Professional Behaviour

"It is the responsibility of all members of the Faculty of Engineering, students, staff and faculty, to adhere to and promote standards of professional behaviour that support an effective learning environment that prepares graduates for careers as professionals...."

You are advised to read the Faculty of Engineering document Standards for Professional Behaviour which contains important information regarding conduct in courses, labs, and in the general use of facilities.

<http://www.uvic.ca/engineering/current/undergrad/index.php#section0-23>

Cheating, plagiarism and other forms of academic fraud are taken very seriously by both the University and the Department. You should consult the Undergraduate Calendar for the UVic policy on academic integrity.

Policy on Academic Integrity

<http://web.uvic.ca/calendar2015-09/FACS/UnIn/UARe/PoAcl.html>