



**COURSE OUTLINE**  
**MECH 390 Energy Conversion**  
**Spring 2014**

**Course Web Site**      <http://moodle.uvic.ca/course/view.php?id=22105>

**Instructor**

Dr **Henning Struchtrup**  
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**Office Hours**

Days: **Open door**  
Time:  
Location: **EOW 511**

**Lectures**

**A** – Section(s): A01  
Days: TWF  
Time: 9:30-10:20  
Location: Bob Wright A 104

**Labs**

<b>B</b> – Section(s)	<b>Days</b>	<b>Time</b>	<b>Bldg/Rm</b>
B01	T	4:30-7:30	ELW A144
B02	F	11:30-1:30	ELW A144

**Tutorials**

<b>T</b> – Section(s)	<b>Days</b>	<b>Time</b>	<b>Bldg/Rm</b>
T02	T	3:30-4:20	CSC 125
T01	W	11:30-12:20	CSC 108

**Required Text**

Title: MECH 390  
Lecture Notes  
Author: Henning  
Struchtrup  
Publisher: posted on moodle  
Year: 2014

**Optional Text**

Title: Thermodynamics  
Author: Cengel & Boles  
Publisher: McGraw-Hill  
Year: any

**Other Reference Material:**

Additional material, e.g., lab manuals and diagrams, will be posted on the course web site

**Assessment**

Assignments	15	%	
Labs	15	%	
Mid-Term	20	%	Mid-Term Date: TBA
Final	50	%	

**NOTES:**

**(a) You must obtain a passing grade in the final examination to pass the course**

**(b) Midterm and Final are closed book examinations.** Tables and a formula sheet will be provided together with the questions.

**(c) Assignments:** Assignments will be posted weekly. Only some of the problems will be marked. The correct numerical answers for the problems will be given on the webpage after the assignment is collected, so that you can check your own work (should I forget to post the solution, please notify me). The assignments try to catch the core principles, processes and problems. You should work through as many of the other problems in the book as possible.

**(d) Tutorials:** Sample problems will be discussed and solved under the guidance of a TA in the tutorials.

**(e) Labs:** There are three laboratory experiments: (1) Rankine cycle; (2) Stirling Engine which can run as heat engine, refrigerator, or heat pump; (3) HVAC experiment.

Scheduling details and lab manuals will be posted on the web.

For the labs, the class is divided into groups of 3 students. Each group has to hand in one report for each experiment. Strict deadline for the reports is *two weeks* after the lab. A proper report should be written such that a person who does not know experiment and manual, can understand the purpose of the experiment, the experimental procedure, the evaluation of data, and the conclusions.

The following marking scheme should give you an idea of the expectations:

- Summary 1
- Introduction 1
- Experimental Procedure/Theory 1
- Results 1
- Discussion 3
- Conclusions 2
- Spelling/Grammar/Presentation 1
- Total 10**

Students who have attended the labs in previous years: You will only have to do labs which were not part of the course previously. Please come to my office with some proof of your previous attendance.

### **Syllabus:**

In this course we will analyze thermal systems on the basis of the laws of thermodynamics. A main goal is to understand the processes in a broad variety of energy conversion devices. Emphasis will be put (a) on the study of the efficiency of these devices (b) efficiency improvements by changing the process details, (c) discussion of irreversible losses.

Among the devices considered are Stirling, Otto, Diesel, Brayton, Rankine, air engines incl. turbofan bypass engines, rocket motors, heat pumps and refrigerators, (de)humidifiers and air conditioning systems, and combustors.

## **Course outcomes:**

Students who successfully complete this course will be able to:

- **Efficiency, work loss**
  1. Combine first and second law to relate entropy generation to work loss.
  2. Quantify work loss for standard irreversible processes and simple technical applications.
  3. Differentiate between internal and external losses.
  4. Provide a rationale for the need for loss reduction to reduce operating costs while improving sustainability.
- **Advanced power and cooling cycles**
  5. Explain and analyze advanced thermodynamics cycles (multistage, feedwater heaters, cascade refrigeration) based on first and second law.
  6. Describe process improvement through reduction of external and internal irreversibilities
  7. Select technical solutions based on detailed thermodynamic analysis.
- **Air engines**
  8. Assess air engine—incl. turbofan— performance based on a detailed analysis using first and second law.
  9. Evaluate internal and external losses.
  10. Justify turbofan engines as means to improve efficiency by reducing external loss.
- **Compressible flow, rocket engines**
  11. Describe compressible flow with differential relations derived from 1st and 2nd law, and property relations.
  12. Analyze flows through converging and diverging ducts.
  13. Identify and model nozzles and diffusers in sub-and supersonic conditions.
  14. Determine thrust of rocket engines.
  15. Explain working principles of ramjet and scramjet.
- **Ideal gas mixtures, psychrometrics**
  16. Extend first and second law, and property relations, to mixtures of ideal gases.
  17. Analyse typical processes for gas mixtures.
  18. Determine entropy of mixing and understand mixing as irreversible process.
  19. Describe moist air as mixture of air and vapor with varying amount of vapor.
  20. Construct and use the psychrometric chart to determine thermodynamic properties of moist air.
  21. Apply mass conservation and first law to air conditioning processes.
  22. Configure basic HVAC systems (heating/cooling, humidification/dehumidification).
- **Combustion**
  23. Formulate mole balances, and first and second law for combustion processes.
  24. Balance amount of chemical species, including water.
  25. Describe the relevance of and determine the dewpoint of product stream.
  26. Use property tables and tables for enthalpy of formation to extract required property values.
  27. Determine heat of reaction, heat exchange in combustion processes.
  28. Describe combustion as irreversible process and determine the associated work loss.

## Final Grade

The final grade obtained from the above marking scheme will be based on the following percentage-to-grade point conversion:

90 ≤	A+ ≤ 100
85 ≤	A < 90
80 ≤	A- < 85
77 ≤	B+ < 80
73 ≤	B < 77
70 ≤	B- < 73
65 ≤	C+ < 70
60 ≤	C < 65
50 ≤	D < 60
35 ≤	E < 50
	F < 35
	N

Fail, conditional supplemental exam\* - for undergraduate courses only.

Fail, no supplemental exam.

Fail, did not write examination or otherwise complete course requirements by the end of the term or session; no supplemental exam.

\* The rules for supplemental examinations are found on page 81 of the current 2009/10 Undergraduate Calendar.

Term in which E Grade was obtained:	Application Deadline for Supplemental Exam	Supplemental Exam Date
First term of Winter Session (Sept – Dec)	Following February 28	First week of following May
Second term of Winter Session (Jan – Apr)	Following June 30	First week of following September
Summer Session (May – Aug)	Following October 31	First week of following January

Deferred exams will normally be written at the start of the student's next academic term; i.e., approximately 4 months following the deferral of the exam.

## Guidelines on Religious Observances

1. Where classes or examinations are scheduled on the holy days of a religion, students may notify their instructors, at least two weeks in advance, of their intention to observe the holy day(s) by absenting themselves from classes or examinations.
2. Instructors will provide reasonable opportunities for such students to make up work or missed examinations.
3. Students will cooperate by accepting the provision of reasonable opportunities for making up work or missed examinations.
4. The University Secretary's Office will distribute a multi-faith calendar to each academic unit annually.

## Commitment to Inclusivity and Diversity

The University of Victoria is committed to promoting, providing and protecting a positive, supportive and safe learning and working environment for all its members.

## Standards of Professional Behaviour

You are advised to read the Faculty of Engineering document Standards for Professional Behaviour at <http://www.engr.uvic.ca/policy/professional-behaviour.php> which contains important information regarding conduct in courses, labs, and in the general use of facilities.

Cheating, plagiarism and other forms of academic fraud are taken very seriously by both the University and the Department. You should consult

<http://web.uvic.ca/calendar2009/FACS/UnIn/UARe/PoAcI.html> for the UVic policy on academic integrity. *"The University reserves the right to use plagiarism detection software programs to detect plagiarism in essays, term papers and other assignments."* Pg 32, University Calendar

**Late Assignments:** No late assignments will be accepted unless prior arrangements have been made with the instructor at least 48 hours before the assignment due date.

**Coursework Mark Appeals:** All marks must be appealed within 7 days of the mark being posted.

**Attendance:** We expect students attend all lectures and labs. It is entirely the students' responsibility to recover any information or announcements presented in lectures from which they were absent.

**Electronic Devices:** No unauthorized *audio* or video recording of lectures is permitted. Calculators are only permitted for examinations and tests if explicitly authorized and the type of calculator permitted may be restricted. No other electronic devices (e.g. cell phones, pagers, PDA, etc.) may be used during examinations or tests *unless explicitly authorized*.