Faculty of Engineering

Department of Mechanical Engineering

COURSE OUTLINE

MECH 390 Energy Conversion

Spring 2017 (201701)

Course Web Site:	https://coursespaces.uvic.ca/course/view.php?id=21428

Instructor	**Office Hours**
Dr. Henning Struchtrup	Open Door, whenever I am in
Phone: 250-721 8916	**or:** send e-mail to schedule appointment
E-mail: struchtr@uvic.ca	Location: EOW 511

Prerequisites: MECH 240

LECTURE DATE(S)

Section: A01 /CRN22165	Days: TWF	Time: 9:30 – 10:30	Location: DSB C106

TUTORIAL SECTIONS

Section:	Days:	Time:	Location:
T01: Tutorial	F	14:30 – 15:20	CLE A127
T02: Question Period	T	13:30 – 14:20	ECS 116

LAB SECTIONS

Section: B (Multiple)	Days:	Time:	Location:
B01:	M	10:00 – 11:00	ELW A144
B02:	T	11:30 – 12:30	ELW A144
B03:	T	12:30 – 13:30	ELW A144
B04:	Th	10:00 – 11:00	ELW A144
B05:	F	11:30 – 12:30	ELW A144
B06:	F	12:30 – 13:30	ELW A144
B07:	F	13:30 – 14:30	ELW A144
B08:	F	15:30 – 16:30	ELW A144

TA Name	**E-mail**	**Office**
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Required Text	**Optional Text**
Title: ***Thermodynamics and Energy Conversion***	Title: *Thermodynamics: An Interactive Approach*
Author: **Henning Struchtrup**	Author: Subrata Bhattacharjee
Publisher/Year: **Springer 2014**	Publisher: Prentice Hall

Download **free e-book** or order printed e-book (*MyCopy Softcover Edition*) for USD 25 (connect through UVic network, or use UVic VPN from home): http://link.springer.com/book/10.1007%2F978-3-662-43715-5 *Hard Cover:* http://www.springer.com/us/book/9783662437148	***Alternative Books***: Cengel & Boles: *Thermodynamics - An Engineering Approach*, McGraw-Hill Moran & Shapiro: *Fundamentals of Engineering Thermodynamics*, Wiley Borgnakke & Sonntag: *Fundamentals of Thermodynamics*, Wiley
Reference Materials: will be posted on the course webpage. We have a site license for TEST (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:

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.

LEARNING OUTCOMES: At the end of this course, students will be able to:

1. **Quantify and qualify irreversible losses**
    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; and
    4) provide a rationale for the need for loss reduction to reduce operating costs while improving sustainability.
2. **Explain and analyze advanced thermodynamics cycles based on first and second law;**
    1) Multistage cycles, feedwater heaters, cascade refrigeration
    2) Describe process improvement.
    3) Through reduction of external and internal irreversibilities, select technical solutions based on detailed analysis.
3. **Explain, and analyze air craft engines**
    1) Assess air engine performance based on a detailed analysis using the 1st and 2nd law;
    2) evaluate internal and external losses;
    3) justify turbofan engines as means to improve efficiency by reducing external loss
4. **Explain, analyze and apply compressible flow behavior**
    1) Describe compressible flow with differential relations derived from 1st and 2nd law
    2) apply compressible flow to converging and diverging ducts,
    3) identify and model nozzles and diffusers in sub-and supersonic conditions;
    4) analyze flow through converging-diverging ducts as nozzles and diffusers,
    5) determine thrust of rocket engines;
    6) explain working principles of ramjet and scramjet.
5. **Understand and apply thermodynamic description of mixtures**
    1) Formulate first and second law, and property relations, for mixtures of ideal gases
    2) apply ideal gas mixtures and psychometrics to typical processes;
    3) determine entropy of mixing and understand mixing as irreversible process;

6. **Understand and apply thermodynamic of moist air (psychrometrics) and use for the analysis of HVAC applications**
    1) describe moist air as mixture of air and vapor with varying amount of vapor;
    2) construct and use the psychrometric chart to find property data for moist air;
    3) apply mass conservation and first law to air conditioning processes;
    4) configure basic HVAC systems (heating/cooling, humidification/dehumidification).
7. **Formulate and apply the thermodynamic laws for the analysis of combustion processes**
    1) Formulate mole balances, as well as first and second law for combustion processes;
    2) balance chemical species, including water;
    3) describe the relevance of and determine the dewpoint of product stream;
    4) use property tables and tables for enthalpy of formation to extract required property values;
    5) determine heat of reaction, heat exchange in combustion processes;
    6) Describe combustion as irreversible process and determine associated work loss.

Weight & Date(s) of Assessments:	**Weight**	**Date**
Assignments:	15%	weekly
Labs	15%	As scheduled
Mid-term	20%	Date: TBA
Final Exam	50%	Date: TBA

Note: Failure to pass the final exam will result in a failing grade for the course

ASSIGNMENTS

Assignments will be posted weekly. Only some of the problems will be marked, due to large student numbers. 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 or the TEST website as possible.

LABORATORIES

There are two laboratory experiments: (1) Stirling Engine which can run as heat engine, refrigerator, or heat pump; (2) HVAC experiment. Scheduling details and lab manuals will be posted on the web.
For the labs, the class is divided into groups of 3 or 4 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.

NOTE: Failure to pass the final exam will result in a failing grade for the course.
Midterm and Final are closed book examinations. Formula sheet, tables with property data will be provided

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.

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 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.

Faculty of Engineering
Department of Mechanical Engineering
COURSE OUTLINE

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, (2017) http://web.uvic.ca/calendar2017-01/undergrad/info/regulations/attendance.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/assets/docs/professional-behaviour.pdf

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/calendar2017-01/undergrad/info/regulations/academic-integrity.html#

Equality

This course aims to provide equal opportunities and access for all students to enjoy the benefits and privileges of the class and its curriculum and to meet the syllabus requirements. Reasonable and appropriate accommodation will be made available to students with documented disabilities (physical, mental, learning) in order to give them the opportunity to successfully meet the essential requirements of the course. The accommodation will not alter academic standards or learning outcomes, although the student may be allowed to demonstrate knowledge and skills in a different way. It is not necessary for you to reveal your disability and/or confidential medical information to the course instructor. If you believe that you may require accommodation, the course instructor can provide you with information about confidential resources on campus that can assist you in arranging for appropriate accommodation. Alternatively, you may want to contact the Resource Centre for Students with a Disability located in the Campus Services Building.
The University of Victoria is committed to promoting, providing, and protecting a positive, and supportive and safe learning and working environment for all its members.

Resource Centre for Students with Disabilities
http://www.uvic.ca/services/rcsd/

Accommodation of Religious Observance (AC1210)
http://web.uvic.ca/calendar2017-01/general/policies.html

Discrimination and Harassment Policy (GV0205)
http://web.uvic.ca/calendar2017-01/general/policies.html