University of Victoria

DEPARTMENT OF MECHANICAL ENGINEERING

SPR2009 MECH 390: ENERGY CONVERSION

Instructor

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Office Hours: Friday, 2:30-3:30pm; EOW 521
Appointments for other times, or open door.

Teaching Assistants:

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Problem sets, Lab schedules, assigned readings and supplemental material will be posted on the Moodle site for MECH390.
To access Moodle, type the URL of Moodle at UVic: **http://moodle.uvic.ca**
Login to Moodle using your NetLink ID and Password, select MECH390.

If you are new to Moodle, see http://www.moodlehelp.uvic.ca/student/index.php
For student FAQs http://www.moodlehelp.uvic.ca/student/studentfaq.php
Troubleshooting http://www.moodlehelp.uvic.ca/student/troubleshoot.php
For Moodle support staff help, email: moodle@uvic.ca

Lectures: Tuesday, Wednesday, Friday 10:30-11:20; **ECS 116**

Tutorial: Tuesday, 12:30-1:20; **ECS 125**

Laboratory Session Times in **ELW B130***:* Tuesday 3:30-5:20 pm
Friday 11:30am-1:20 pm

Each group of 4 students must sign up for any 2 sessions in the term.
Bridge (transfer) students sign up for Tuesdays only, to prevent schedule conflict.

Textbook Çengel, Y.A. and Boles, M.A., *Thermodynamics - An Engineering Approach*, 6th Edition, McGraw-Hill, 2008.

Calendar Course Description
Thermal power generation, vapour and gas cycles, refrigeration and heat pumps, non-reacting gas mixtures and psychrometrics, reactin mixtures, combustion and electro-chemical energy conversion. Exergy (ability to produce work) and second law analysis.

Course Outline	**(Week#)**
1. Review of thermodynamic principles (parts of Ch 1-6)	1-2
2. Thermodynamic cycles in closed systems, including Stirling cycles	2-3
3. Internal combustion engines, open systems	4
First term exam Thu 5th Feb, 7-9 pm, ECS116.	
4. Gas Turbine Power Plants and Aircraft Propulsion	5-6
5. Liquid-vapour mixtures, vapour power systems, steam cycles	7-8
Second term exam Mon 9th Mar, 7-9 pm, ECS125.	
7. Refrigeration Cycles	9
8. Mixtures, Psychrometrics	10-11
9. Special Topics	12
11. Review	12
Final Exam	

Laboratory
There are two laboratory experiments in this course:

- Stirling engine as heat engine, refrigerator and heat pump
- HVAC (Heat - Ventilation - Air-Conditioning): refrigeration and psychrometrics

Details of objectives, background, apparatus and conduct of experiment are available as laboratory manuals from the Moodle course site.

Lab Reports and Homework Assignments should be dropped in labeled boxes located opposite ELW A136

Assignments will be given on a regular basis and must be submitted. As they are central to the learning process, all problems must be worked through. A random selection of questions will be marked.

Exams
Two midterms and a final exam will be scheduled. In addition unscheduled bonus "Flash Quizzes" of about 5-10 min. duration will be assigned during some of the classes. These will be on various topics discussed in class or from assigned readings. *Marks for these quizzes will be added as a bonus towards the final course grade.*

Grading

Problem Sets	20 %
Labs (2)	15 %
Scheduled Midterms (2)	25 %
Final Exam	40 %
Total	**100 %**

Flash Quizzes Bonus 3%

Note: In order to pass the course, students are required to submit both laboratory reports and to pass the final exam.

Additional Information

- If you are unable to write a midterm due to illness (or other acceptable reasons specified in the calendar), the appropriate portion of the grade will be transferred to the final exam.

- Assignments and labs are designed to further your understanding and provide the opportunity to apply concepts discussed in class. You are encouraged to discuss problem-sets and the approach to problem-solving in small groups, as this helps you gain an appreciation for the scope and tools of the subject. You must work through the problem steps on your own and submit individual work which you are able to explain.

- Late acceptance of assignments and lab reports can lead to poor time management, is unfair to fellow students and disruptive for the teaching assistants who grade them. Late submissions will not normally be accepted – they may be accepted late at the discretion of the grading TA and Instructor, in cases of extraordinary difficulty, but only if such difficulty is discussed before the submission deadline.

- Please review Undergraduate Academic Regulations (pg 31-37 of 2008-2009 UVic Undergraduate Calendar).

MECH390: Detailed Outline
(Class Notes include Lecture summaries put up on Moodle)
[Chapter-Section] indicates where text (Cengel&Boles 6th Edition) has been most used.

Review (parts of Chapters 1-6)
Energy Conversion –role of the capacity to do useful work
First and Second Laws and Corollaries
Property relations
Energy balance, work and heat
Ideal gas relations –thermal and caloric equations of state.
Gibbs (TdS) relations
Entropy balance for closed systems
Irreversible work losses
Heat and work: P-v-diagram and T-s-diagram [7-5]
Entropy of an ideal gas, isentropic processes [7-9], Review notes on moodle.

Gas Power Cycles in closed systems
Heat and work in standard processes: isochoric, isobaric, adiabatic, isothermal, polytropic
Carnot process and its efficiency [6-7, 6-8, 6-9, 6-10, 6-11,9-2]
Stirling cycle as heat engine [9-7]
External and Internal Irreversibility
Second Law Efficiency
Effect of finite temp difference heat transfer –entropy generation
Scale buildup in power plant piping; Resistive space heating
Example: Carnot cycle with heat transfer loss
Example: Space heating
Regeneration and internal heat exchange [9-7]
Reciprocating engines: Otto and Diesel cycle [9-5,9-6]

Open systems
Mass, energy, entropy balance
Basic open system devices: compressor, turbine, throttle [5-4, 7-12]
Basic open system devices: nozzle, diffuser, heat exchanger [5-4,7-12]
Isentropic efficiencies [7-12]

Gas turbine power plants
Brayton cycle, efficiency and pressure ratio [9-8]
regenerative gasturbine cycles [9-9]
intercooling and reheat [9-10]

Aircraft propulsion
Aircraft engines [9-11]
Froude efficiency, turbojets and turbofan

ramjet and scramjet [9-11]
speed of sound [17-2]
area-velocity relation for nozzles and diffusors [17-3]
subsonic and supersonic nozzle flow [17-3,17-4]

Liquid-vapor mixtures,vapor power systems

p-T-diagram, p-v-diagram, T-s-diagram etc. [3-4]

Saturated states and p-v-T- relations [3-5]

Steam cycles

Basic Rankine cycle [10-2]

Rankine cycle with superheating and reheat [10-5]

regenerative cycles: open and closed feedwater heaters [10-6]

Cogeneration power plants [10-8]

Combined gas-vapor cycles [10-9]

Refrigeration cycles

refrigeration cycles and heat pumps [11-1, 11-2]

standard cycles [11-3, 11-4]

cycles with intercooling: heat exchangers, flash and mixing chambers [10-7]Cascade and Multistage Refrigeration Cycles [11-7]

Air Liquefaction [11-7]

Mixtures

Mixtures of ideal gases [13-1]

partial pressure [13-2]

Gibbs-Dalton and Amagat Laws [13]

mass and mole fraction [13-1]

properties of mixtures [13-3]

entropy of mixing

Psychrometrics

humidity ratio and relative humidity [14-1,14-2]

enthalpy per unit mass of dry air

dew point [14-3]

wet bulb temperature [14-4]

psychrometric chart [14-5]

air conditioning processes: dehumidification and humidification [14-7]