# Thermodynamics
# ENGG 3260
# Fall 2008


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| Instructor: | Khosrow Farahbakhsh, Ph.D., P.Eng.<br>Rm. 216, Thornbrough Bldg.<br>khosrowf@uoguelph.ca<br>Ext. 53832 |
| Lecture schedule: | M, W, F 9:30 – 10:20 MCKN 117 |
| Tutorials: | Consult the WebAdvisor |
| GTA: | Joel Citulski (jcitulsk@uoguelph.ca)<br>Ian Summerscales (isummers@uoguelph.ca ) |
| Prerequisites: | As stated in the U of G Calendar |
| Textbook: | Yunus A. Çengel and Michael A. Boles, 2006.<br>Thermodynamics – An Engineering Approach<br>6th edition, McGraw Hill Higher Education |


## *Course Description*

Thermodynamics, once known as the science of heat, has now become a tool that is revolutionizing the way we perceive the world. Whether contemplating evolution or economics, energy conservation or computational science, one cannot but feel the omnipresence of thermodynamics. As engineers, we study thermodynamics not only to understand the limits of our technology, but to challenge the current notions of energy, work, and waste. This course will facilitate the learning of fundamental principles of thermodynamics and an appreciation of their importance in the engineering practice. In addition to exploring the history of thermodynamics, we will learn the practical applications of such topics as energy transfer, first and second law of thermodynamics, entropy, energy analysis and exergy, and thermodynamic cycles. Einstein once said that laws of "[Thermodynamics] … will never be overthrown" and Frederic Keffer said that "the future belongs to those who can manipulate entropy". Let's learn why!

### *Evaluation*

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| Design Project | 25% |
| Individual Energy Usage | 10% |
| Logbooks | 5% |
| 3 Quizzes | 30% |
| Final Exam | 30% |

### *Tutorials and Review Problems*

Tutorials will be used for two purposes: to strengthen students' understanding of thermodynamics through reviewing examples, and to discuss the assigned projects. A large number of review problems with solutions will be made available to the students. These review problems provide an opportunity for the students to better understand the course materials. All students are strongly encouraged to complete these problems either individually or in groups. Additional examples will be provided by the teaching assistants during the tutorials.

### *Design Project*

The project for this year is design of a co-generation system. Co-generation is simultaneous production of power and heat recovery. In general, co-generation facilities are three to four times more efficient than stand alone power plants. The power generation system will be based on the Sterling engine concept, however, other designs will also be considered. This project will be conducted in groups of four to five students. The project involves design and build of the power generation system, design and build of heat recovery system and energy and entropy balance analysis. A portion of the tutorials will be devoted to discussing these projects. Each group is also expected to hold regular meetings outside the tutorial sessions to discuss the progress of their project. Aside from applying the principles of thermodynamics, the project will enable the students to enhance their group skills and sharpen their research and problem-solving abilities. More details will be provided during the class.

### *Individual Energy Usage*

We use energy for all activities however, we are often unaware of the magnitude and forms of energy we use in our daily life. This project is designed to enable students to gain an appreciation of energy use, its magnitudes and diverse forms. At the completion of this project, each student will have determined his/her average daily energy consumption and consequent $CO_2$ generation. The project will involve a short report and energy balance analysis. More details will be provided in the class.

### *Logbooks*

Each student will keep a logbook in which he/she will record all important information relevant to the term or term/design project. The information should include a brief record of all meetings attended and decisions made, research conducted for the projects and other information such as time spent on the project, rough calculations, and conceptual design drawings, etc. In short, the logbooks are

records of individuals' involvement with their term or term/design projects. Please refer to your second-year design course for how to keep an effective logbook. The logbooks must be brought to each quiz for review by TAs and submitted for final evaluation at the end of the term. **Logbooks are a must for getting a passing grade on the design projects.**

### *Quizzes and Final Exam*

All materials that have been covered before the quiz will be included. Quizzes are closed book. A formula sheet and appropriate tables and charts will be provided.

### *Topics Outline*

1. Introduction
2. A brief history of thermodynamics
3. Basic concepts and definitions
4. Properties of pure substances
5. Energy transfer by heat, work, and mass
6. The first law of thermodynamics
7. The second law of thermodynamics
8. Applications of entropy
9. Exergy – Introduction and application

### *Recommended Readings*

Hans Christian von Baeyer, 1998. Warmth Disperses and Time Passes. The Modern Library, New York.

Enrico Fermi, 1936. Thermodynamics. Dover Publications, New York.

P. W. Atkins, 1994. The 2nd Law, Energy, Chaos, and Form. Scientific American Books, New York.

H. C. van Ness, 1969. Understanding Thermodynamics. Dover Publications, New York.

Materials posted on the course WebCT.

### *Disclaimer*

The instructor reserves the right to change any or all of the above in the event of appropriate circumstances, subject to University of Guelph Academic Regulations.