
MECH 3800 - Engineering Thermodynamics II

Fall 2009

1. GENERAL CONTEXT

Thermodynamics, fluid mechanics and heat transfer form an important branch of mechanical engineering called thermal fluid. Thermodynamics is the science of energy and of its conversion to and from mechanical energy. It usually deals with an ensemble of macroscopic thermodynamic processes, whereas fluid mechanics and heat transfer deal with the details of each of these processes.

A good comprehension of the various thermodynamic processes is essential to the practice of engineering. A quick look around will convince you that these processes are omnipresent in our modern society: refrigerators, the power cycle in all sort of power plant, the thermal processes present in a heating, ventilation and air conditioning (HVAC) system and the concept of compressible flow behind every jet engine.

This thermodynamics course is the second one you will encounter during your undergraduate study in mechanical engineering. The first course dealt with the fundamentals of thermodynamics, the properties, states, processes and cycles encountered in engineering and with the laws necessary to understand them. During this course, we will build on these concepts in order to delve more deeply into the various thermodynamic processes and focus on applied systems.

2. CLASS DESCRIPTION

Objectives: Develop the necessary skills in order to analyse and model the various processes encountered in thermodynamics.

Content: The basic thermodynamic laws and principles are applied to various engineering problems, with emphasis on non-reacting mixtures, psychrometry, combustion processes, enthalpy of formation, chemical equilibrium, compressible flow, expansion and compression processes, vapour compression and absorption refrigeration, and heat pumps.

Prerequisite: ENGI 2800 and ENGI 2300

3. LECTURES: Tuesday and Thursday, 8:35 to 9:55, room B311

4. TUTORIAL SESSIONS

Friday: 13:35 to 16:25, room B311

Tutorial time will be used mainly for solving practice problems, and assignment discussion.

5. INSTRUCTOR AND TEACHING ASSISTANT COORDONATES

INSTRUCTOR

Dr. DOMINIC GROULX, P.Eng, ing.

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6. OBJECTIVES

GENERAL OBJECTIVE

- Acquire the skills needed to properly understand and solve problems encountered in thermodynamics.

SPECIFIC OBJECTIVES

At the end of this course, the student should be able to:

- Formulate the mathematical equations governing the thermodynamic processes;
- Understand the physical significance of these equations;
- Solve these equations;
- Justify the various assumptions made in class;
- Explain and analyse the various cycles studied during the class;
- Work with a psychrometric chart;
- Understand the effect of compressibility;
- Explain the various concepts related to chemical reaction and equilibrium;

7. RESPONSIBILITIES AND TASKS

During this class, the student is considered to be *an engineer in formation*. His work is not only to get good grade, but also to prepare him or herself to skilfully assume his future job of engineer. With this in mind, the student does have the full responsibility to plan and manage his learning. Keep in mind that fundamental engineering knowledge/thinking is acquired by repetition and problem solving. Here are the three main tasks under the responsibility of the student.

The first task is to do the necessary work in order to understand and learn the concepts seen in class. This work consists in reading the suggested material prior to and after class. The lectures purpose is to present, explain and complete the information in relation to the main concepts presented in class. The second task is to actively participate in the activities taking place during the class. Discussions and problem solving (alone or in team) are the principal activities in which the participation of the student is demanded and advised. Finally, the student's third task is to use all the resources at his disposition in order to master the fundamental knowledge and the concepts needed to analyse and model the thermodynamic processes studied.

The instructor's responsibility is to organise and manage the environment in which the student is coming to learn. To this end, he will present the necessary learning resources and animate the class activities. He is also available to help students with any kind of problem they could have regarding the content of the class. As usual, he plays a role in the grading process.

The teaching assistants help the instructor when it comes to preparing documents and assignments for the class, to monitor exams and to grade assignments and exams.

8. METHODOLOGY

Every lecture will be organised in a way that favour a good comprehension of the presented concepts and an active appropriation of knowledge. Generally, the instructor's formal lecture will alternate with problem solving presentations and period of questions and answers. In order for the student to actively participate during the lectures, they would need to have read the class materials before hand.

9. CLASS CONTENT

The following concepts and applications will be studied in this class

- Review of Basic Laws and Relations of Thermodynamics;
- Transient Energy Analysis;
- Ideal Gas Mixtures, Psychrometry and Air-Conditioning;
- Refrigeration Cycles;
- Chemical Reactions;
- Chemical Equilibrium;
- Compressible Flow;
- Irreversibility and Availability (if there is time left);

The relative importance of these different themes, hence the number of hours given to each of them, is not equal. A calendar presenting the time accorded to each of the theme will be given to the student.

10. GRADING

Various exams and assignments will be use to evaluate the understanding of the student during the term. A description of each of these exams and assignments is here presented:

1. Assignments (total : 15 % for all the assignments)

Each week, you will be a given a set of assignment problems. The assignments will be posted online every Friday (<http://lamte.me.dal.ca/MECH3800.htm>). Unless announced otherwise, each assignment will be due at **16:30, the Friday of the following week**; assignments must be submitted in accordance with the document “Assignment Preparation and Problem Solution Presentation Guidelines” found on the course website. Solutions will be posted online a week after each assignment has been handed over. No late assignments will be accepted.

2. Term Exams (total : 40 % for the two exams)

There will be two term exams. The content covered by these exams will correspond to what has been covered in class the weeks before the exams. The exams will present two types of questions: comprehension questions and problems to solve. They will be of the open book, open notes variety.

3. Final exam (45 %)

A final exam will be given at the end of the term (during the final examination period). This exam will be built in order to verify that the student acquired the skills and knowledge needed by a mechanical engineer. This exam will be comprehensive. It will also be of the open book, open notes variety.

A supplementary final exam will be given only to those who fail marginally (45-50%). The supplementary exam will only replace the final exam mark.

ILLNESS

In cases involving serious medical illness of students, all matters shall be resolved in consultation with the Associate Dean's Office as per departmental and faculty regulations.

Pandemic H1N1 Influenza Advisory in relation to Academic Continuity

In the event of an escalation of the pandemic H1N1 influenza virus, the University may need to authorize Academic Units to change elements of class schedules and/or evaluation plans as outlined in course syllabi. Any change is intended to support the primary goal of reducing the risk of spreading a pandemic influenza among students, faculty and staff.

Although it is difficult to predict the severity of the pandemic, the University is committed to minimizing the impact on student's academic progress. Therefore, every effort will be made to provide students with options for continued learning and for continued fair evaluations.

Changes may include but are not limited to:

- Adjustments to course assignments;
- Changes to the dates of exams;
- Arrangements for alternative evaluations for students affected by H1N1 influenza virus;
- Adjustments to work terms;
- Modification of marks awarded for participation;
- Adjustments to attendance policies.

Any alternative plan made in individual courses may be superseded by University-wide or Government measures to reduce the spread of the pandemic H1N1 influenza virus.

MISSED MIDTERM

There is no supplementary midterm. If a student does not write the midterm, that student may submit a written request that the final exam mark be prorated to 67.5% or 85%. Requests must be received within two weeks of the midterm date. Requests must include justification as to why the midterm was not written; requests without proper justification will be denied. Students who have written the midterm may not request a proration of their final exam mark.

11. BIBLIOGRAPHICAL REFERENCES

TEXTBOOK

SONNTAG, R.E., BORGNAKKE, C., VAN WYLEN, G.J. (2003) *Fundamentals of Thermodynamics*, 6th edition, John Wiley & Sons, 794 p.

ADDITIONAL REFERENCES

BLACK, W.Z., HARTLEY, J.G. (1996) *Thermodynamics*, 3rd edition, Harper Collins, 917 p.

CENGEL, Y.A., BOLES, M.A. (2006) *Thermodynamics, an Engineering Approach*, 6th edition, McGraw-Hill, 1018 p.

EASTOP, T.D, McConkey, A. (1993) *Applied Thermodynamics for Engineering Technologist*, 5th edition, Pearson Prentice Hall, 715 p.

ENGEL, T., Reid, P. (2006) *Thermodynamics, Statistical Thermodynamics and Kinetics*, Pearson Benjamin Cummings, 589 p.

KAMINSKI, D.A., JENSEN, M.K. (2005) *Introduction to Thermal and Fluid Engineering*, John Wiley & Sons, 783 p.

MORAN, M.J., SHAPIRO, H.N. (2004) *Fundamentals of Engineering Thermodynamics*, 5th edition, John Wiley & Sons, 874 p.

MORAN, M.J., SHAPIRO, H.N., MUNSON, B.R., DeWITT, D.P. (2003) *Introduction to Thermal Systems Engineering: Thermodynamics, Fluid Mechanics and Heat Transfer*, John Wiley & Sons, 562 p.

SCHMIDT, P.S., EZEKOYE, O.A., HOWELL, J.R., BAKER, D.K. (2006) *Thermodynamics: an Integrated Learning System*, John Wiley & Sons, 458 p.

SONNTAG, R.E., BORGNAKKE, C. (2007) *Introduction to Engineering Thermodynamics*, 2nd edition, John Wiley & Sons, 617 p.

TESTER, J.W., Modell, M. (1997) *Thermodynamics and Its Applications*, 3rd edition, Prentice Hall, 936 p.