

**UNIVERSITY OF NEVADA, LAS VEGAS**  
**Mechanical Engineering Department**  
**Advanced Thermodynamics**

ME 711

Fall 2016

**Course Objectives and Comments:** The objective of this course is to examine the concepts of basic thermodynamics from two perspectives. Initially, a "review" from typical engineering thermodynamics textbooks will be given. Review is placed in quotations because, depending upon the course(s) already taken by the student, it is possible that some of the topics may not have been covered. The remainder of the course will concern itself with a postulatory approach to many of the same topics covered in the review. This approach tends to be more mathematical in its context and quite different compared to typical engineering thermodynamics approaches.

**Course Learning Outcomes:** By the end of the semester, students will be able to:

- Find thermodynamic properties of materials from a variety of reference sources.
- Solve engineering problems using the principals of the First and Second Laws of Thermodynamics.
- Understand the behavior and properties of vapors, air, gases, and gas-vapor mixtures.
- Solve chemical reaction and equilibrium problems.
- Describe reversible processes.
- Solve problems using Legendre Transformations and Maxwell Relations.

**Textbooks:** Required textbook is *Thermodynamics and an Introduction to Thermostatistics, Second Edition*, by Herbert Callen. This will be used in the second half of the course, and at least one copy will be on reserve in the library. For the first half, each student should also have access to a "conventional" engineering thermodynamics book like those authored by Holman, Moran and Shapiro, Cengel and Boles, as well as a variety of others. If you don't have access to a book of this sort, please see the Instructor.

**Grading:** The grading will be based upon periodic homework assignments (approximately once a week) that will include presentations of the solutions to the class by the students, as well as one midterm and the final exam. Distribution of credit is as follows. Homework: 35%. Midterm: 25%. Final Exam: 30%. Class Participation (heavily based upon presentations of homework solutions): 10%.

**Tentative Course Schedule:** Any changes will be announced in class and on web (see below).

<u>Week</u>	<u>Dates</u>	<u>Topic</u>
1	8-29, 31	Review: Vapor Properties, Work, Heat, Process 1 <sup>st</sup> Law
2	9-7	Review: Cycle 2 <sup>nd</sup> Law
3	9-12, 14	Review: Process 2 <sup>nd</sup> Law, Ideal Gas Concepts
4	9-19, 21	Review: Availability and Irreversibility, Vapor Cycles
5	9-26, 28	Review: Air Cycles, Gas-Vapor Mixtures
6	10-3, 5	Review: Chemical Reactions
7	10-10, 12	Review: Chemical Reactions, Equilibrium.
8	10-17, 19*	Equilibrium, Chapter 1 of Callen
9	10-24, 26	Midterm Exam (covers engineering thermodynamics) Chapter 2
10	10-31, 11-2	Chapters 3, 4
11	11-7, 9	Chapters 4, 5
12	11-14, 16	Chapter 6
13	11-21, 23	Chapter 7
14	11-28, 30	Chapters 8, 9
15	12-5, 7	Chapters 12 (Review), 13
16	12-12	Final Exam, 1:00-3:00

\* October 19 is the day for the US Presidential Debate to be held on campus and there may not be any classes allowed on campus. Related activities may also block out classes on the 17th. More details will be known on this as the time approaches.

**Homework:** Periodic assignments for homework will be given in class, and a due date will be specified. Special problems will be given for the first half of the course, and problems from Callen will be used for the second part. Denoted on the assignment of each problem will be a student presenter for the solution. It is expected that the denoted student will present the problem solution to the class at the beginning of the period on the day due. Unless

otherwise specified, this presentation should be short—no more than 4 minutes in duration. Student presenters will need to come to the classroom a little early on the day she/he presents to set up the appropriate visual aid (computer or doc cam). One of the objectives of this aspect is to give students practice in making brief technical presentations. Another objective is to clarify any questions about the submitted homework. It is not necessary to give every detail of the solution to the class, only the main points and answers should be given. Solutions will be posted on the web.

**WebCampus:** All handout materials for this class will be made available on this web site. Homework assignments and solutions will be posted there. See: <https://webcampus.nevada.edu/webct/entryPage.doweбct>. If you are not familiar with the use of this, instructions are given on this website for getting started.

**Thermodynamic Properties and Where to Find Them:** Many of the current engineering thermodynamics books have a set of properties included. Some texts may have a slightly different compilations of substances, but there will be a major set of similarities between each text. Also the ASHRAE HANDBOOK OF FUNDAMENTALS has many properties included with a variety of other information. Other publications specialize in only properties. Included are: Stewart, R. B., et al., THERMODYNAMIC PROPERTIES OF REFRIGERANTS, ASHRAE, 1986. Borgnakke, C., and R. Sonntag, THERMODYNAMIC AND TRANSPORT PROPERTIES, 1997. The World Wide Web is filled with all kinds of special information about everything, including some property evaluation routines. Unfortunately, these sites come and go, so what was available a few months ago can change. **You might do your own search to see what sources you find.** Freeware (on a trial basis) can be downloaded from the URL shown below. These routines give accurate values of all the properties (for any given two properties). We don't have to worry about interpolation any more.

<http://www.gpengineeringsoft.com/pages/products.html>

Steam, R134a, R744 [https://www.ohio.edu/mechanical/thermo/property\\_tables/index.html](https://www.ohio.edu/mechanical/thermo/property_tables/index.html)

ProSim (for purchase) <http://www.prosim.net/en/thermodynamics/simulist.html>

Asimptot: <http://www.asimptote.nl/software/fluidprop>

Matlab: <https://peer.asee.org/a-matlab-toolbox-for-thermodynamic-property-evaluation.pdf>

The Expert System of Thermodynamics: [www.sciencedirect.com/science/article/pii/S0364591608001235](http://www.sciencedirect.com/science/article/pii/S0364591608001235)

Fluid Property Calculator: <https://www.irc.wisc.edu/properties/>

Steam and Gas Tables: <http://www.steamtablesonline.com/>

NIST property evaluations: <http://webbook.nist.gov/chemistry/fluid/>

No claim is made about the completeness or best examples of property evaluation approaches in the above list.

**Library Resources:** Students may consult with a librarian on research needs. For this class, the subject librarian is Sue Wainscott. ([https://www.library.unlv.edu/contact/librarians\\_by\\_subject](https://www.library.unlv.edu/contact/librarians_by_subject)). UNLV Libraries provides resources to support students' access to information. Discovery, access, and use of information are vital skills for academic work and for successful post-college life. Access library resources and ask questions at <https://www.library.unlv.edu>.

**Academic Misconduct:** Academic integrity is a legitimate concern for every member of the campus community; all share in upholding the fundamental values of honesty, trust, respect, fairness, responsibility and professionalism. By choosing to join the UNLV community, students accept the expectations of the Student Academic Misconduct Policy and are encouraged when faced with choices to always take the ethical path. Students enrolling in UNLV assume the obligation to conduct themselves in a manner compatible with UNLV's function as an educational institution.

An example of academic misconduct is plagiarism. Plagiarism is using the words or ideas of another, from the Internet or any source, without proper citation of the sources. See the *Student Academic Misconduct Policy* (approved December 9, 2005) located at: <https://www.unlv.edu/studentconduct/student-conduct>.

**Copyright:** The University requires all members of the University Community to familiarize themselves **with** and to follow copyright and fair use requirements. **You are individually and solely responsible for violations of copyright and fair use laws. The university will neither protect nor defend you nor assume any responsibility for employee or student violations of fair use laws.** Violations of copyright laws could subject you to federal and state civil penalties and criminal liability, as well as disciplinary action under University policies. Additional information can be found at: <http://www.unlv.edu/provost/copyright>.

**Disability Resource Center (DRC):** The UNLV Disability Resource Center (SSC-A 143, <http://drc.unlv.edu/>, 702-895-0866) provides resources for students with disabilities. If you feel that you have a disability, please make an appointment with a Disabilities Specialist at the DRC to discuss what options may be available to you. If you are registered with the UNLV Disability Resource Center, bring your Academic Accommodation Plan from the DRC to the instructor during office hours so that you may work together to develop strategies for implementing the

accommodations to meet both your needs and the requirements of the course. Any information you provide is private and will be treated as such. To maintain the confidentiality of your request, please do not approach the instructor in front of others to discuss your accommodation needs.

**Religious Holidays Policy:** Any student missing class quizzes, examinations, or any other class or lab work because of observance of religious holidays shall be given an opportunity during that semester to make up missed work. The make-up will apply to the religious holiday absence only. It shall be the responsibility of the student to notify the instructor **within the first 14 calendar days of the course for fall and spring courses (excepting modular courses), or within the first 7 calendar days of the course for summer and modular courses**, of his or her intention to participate in religious holidays which do not fall on state holidays or periods of class recess. For additional information, please visit: <http://catalog.unlv.edu/content.php?catoid=6&navoid=531>.

**Transparency in Learning and Teaching**—The University encourages application of the transparency method of constructing assignments for student success. Please see these two links for further information:

<https://www.unlv.edu/provost/teachingandlearning>

<https://www.unlv.edu/provost/transparency>

**Incomplete Grades:** The grade of I—Incomplete—can be granted when a student has satisfactorily completed three-fourths of course work for that semester/session but for reason(s) beyond the student's control, and acceptable to the instructor, cannot complete the last part of the course, and the instructor believes that the student can finish the course without repeating it. The incomplete work must be made up before the end of the following regular semester for undergraduate courses. Graduate students receiving "I" grades in 500-, 600-, or 700-level courses have up to one calendar year to complete the work, at the discretion of the instructor. If course requirements are not completed within the time indicated, a grade of F will be recorded and the GPA will be adjusted accordingly. Students who are fulfilling an Incomplete do not register for the course but make individual arrangements with the instructor who assigned the I grade.

**Tutoring and Coaching**—The Academic Success Center (ASC) provides tutoring, academic success coaching and other academic assistance for all UNLV undergraduate students. For information regarding tutoring subjects, tutoring times, and other ASC programs and services, visit <http://www.unlv.edu/asc> or call [702-895-3177](tel:702-895-3177). The ASC building is located across from the Student Services Complex (SSC). Academic success coaching is located on the second floor of the SSC (ASC Coaching Spot). Drop-in tutoring is located on the second floor of the Lied Library and College of Engineering TEB second floor.

**UNLV Writing Center**—One-on-one or small group assistance with writing is available free of charge to UNLV students at the Writing Center, located in CDC-3-301. Although walk-in consultations are sometimes available, students with appointments will receive priority assistance. Appointments may be made in person or by calling 702-895-3908. The student's Rebel ID Card, a copy of the assignment (if possible), and two copies of any writing to be reviewed are requested for the consultation. More information can be found at: <http://writingcenter.unlv.edu/>.

**Rebelmail:** By policy, faculty and staff should e-mail students' Rebelmail accounts only. Rebelmail is UNLV's official e-mail system for students. It is one of the primary ways students receive official university communication such as information about deadlines, major campus events, and announcements. All UNLV students receive a Rebelmail account after they have been admitted to the university. Students' e-mail prefixes are listed on class rosters. The suffix is always [@unlv.nevada.edu](mailto:@unlv.nevada.edu). **Emailing within WebCampus is acceptable.**

**Final Examinations:** The University requires that final exams given at the end of a course occur at the time and on the day specified in the final exam schedule. See the schedule at: <http://www.unlv.edu/registrar/calendars>.