

Course Information
ENGN 115
Engineering Thermodynamics
Fall 2015

Course Instructor

Dr. Alan Bolind
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Department of Nuclear Engineering
4103 Etcheverry Hall # 1730
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Class Location and Time

MWF 3108 Etcheverry Hall, 10 AM – 11 AM
Tu 3106 Etcheverry Hall, 5 PM – 6 PM

Instructor Office Hours

MWF 4103 Etcheverry Hall, 11 AM – 12 PM (Location will change mid-semester.)
Please contact Dr. Bolind to arrange an appointment if additional time for consultation is needed.

Graduate Student Instructors (GSIs and Readers)

Mauricio Ayllon Unzueta, mayllon@berkeley.edu,
Office Hours: 9:00 AM – 10:00 AM Thursday, 4126 Etcheverry Hall (1106B Etcheverry
Hall during remodeling of 4126)
Sandra Bogetic, sbogetic@berkeley.edu,
Office Hours: 3:30 PM – 4:30 PM Thursday, 4126 Etcheverry Hall (1106B Etcheverry
Hall during remodeling of 4126)

Course Objectives and Outcomes

1. Understanding of the first law of thermodynamics and various forms of work that can occur. An ability to analyze the work and heat interactions associated with a prescribed process path, and to perform a first law analysis of flow systems.
2. A fundamental understanding of the first and second laws of thermodynamics and their application to a wide range of systems.
3. An ability to evaluate entropy changes in a wide range of processes and determine the reversibility or irreversibility of a process from such calculations. Familiarity with calculations of the efficiencies of heat engines and other engineering devices.
4. An understanding of the use of the Gibbs free energy as an equilibrium criterion, and the statement of the equilibrium condition for closed and open systems. An understanding of the interrelationship between thermodynamic functions and an ability to use such relationships to solve practical problems.
5. Familiarity with the construction and principles governing the form of simple and complex one-component pressure-temperature diagrams and the use of volume-temperature and

pressure–volume phase diagrams and the steam tables in the analysis of engineering devices and systems.

6. Ability to determine the equilibrium states of a wide range of systems, ranging from mixtures of gases, mixtures of gases and pure condensed phases, and mixtures of gases, liquids, and solids that can each include multiple components.
7. Familiarity with basic concepts in solution thermodynamics, and an ability to determine whether the equilibrium state is a homogeneous or phase-separated mixture.
8. Understanding of the operation of electrochemical cells and the connection to Gibbs free energy

Topics Covered (See Syllabus)

Course Textbooks

1. Main: *General Thermodynamics*, by D. R. Olander
2. Optional: *Introduction to Thermodynamics of Materials*, Fifth Edition, by David R. Gaskell
3. Very Optional: *Fundamentals of Engineering Thermodynamics*, Third Edition (or later), by Michael J. Moran and Howard N. Shapiro—probably just read it in the library
4. Utterly Optional: *Thermodynamics: An Engineering Approach*, Seventh Edition (or later), by Yunus A. Çengel and Michael A. Boles—definitely just read it in the library
5. Good details: *Engineering and Chemical Thermodynamics*, 2nd Edition, by Milo D. Koretsky

Read Ahead

Students are expected to have read ahead of the class the relevant chapters in the textbook or assigned reading material.

Course Grade

The course grade will be based on homework (10%), three non-cumulative, intermediate examinations (20% each), and one cumulative, final examination (30%).

Homework

There will be a homework assignment after every lecture, and it will generally be due at the beginning of the next lecture. The exact due date will be indicated on each homework assignment. Homework should be turned in at the beginning of the class on the date when it is due, or before; late submittals will not be accepted. The homework assignments will be posted on the course website at least one week in advance so that you can work ahead and avoid conflicts with your personal schedule. Solutions to each homework assignment will be posted on the course website before the next discussion session that is after the assignment is due.

Not every homework assignment will be graded in detail. The choice of whether or not to grade a particular assignment in detail is at the instructor's discretion. If an assignment is not graded in detail, it will be graded as pass/fail (full-credit/no-credit) based upon whether the student made an obvious, honest attempt at answering the questions.

The homework assignments should not be considered as team assignments. While you may discuss with your classmates the problems and the general approaches to solving them, all solutions must be prepared independently. Assignments that show sufficient similarities to those of other classmates or to solutions handed out in class previously may be considered as indicating academic dishonesty (<http://www.asuc.org/honorcode/index.php>). Please show all

work, since the assignments will be graded for the method that you used, as much as for the final answer.

If you have a question about the grading of a problem, after comparing your graded homework with the posted solutions, you can request that your score on that problem be re-evaluated. All such requests must be handled formally by submitting your assignment to the instructor or the GSI/Reader with a written note explaining which problem you want to be reconsidered and why you believe you deserve more credit than you received. Please note that since there will be 37 homework assignments that will together constitute only 10% of the final grade, quibbling over petty points will not be entertained. The main purpose of the homework assignments is to help you to study consistently for the examinations.

Exams

The dates for the exams will be as follows:

- 1st Intermediate Exam: Friday, September 25, in the usual classroom at the usual time
- 2nd Intermediate Exam: Friday, October 23, in the usual classroom at the usual time
- 3rd Intermediate Exam: Friday, December 4, in the usual classroom at the usual time
- Final Exam: Exam Group 1, Monday, December 14, 8–11 AM. Location to be assigned.

Intellectual Dishonesty

Intellectual dishonesty, in the form of cheating, plagiarism, and submitting material as your own when in fact it has been copied from that of a fellow student, is a very serious academic offense and cannot be tolerated. Anyone caught being intellectually dishonest will be referred to the Center for Student Conduct which can result in disciplinary action.

Other Policy

1. ACCOMMODATION OF RELIGIOUS CREED

In compliance with California Education Code, Section 92640(a), it is the official policy of the University of California at Berkeley to permit any student to undergo a test or examination, without penalty, at a time when that activity would not violate the student's religious creed, unless administering the examination at an alternative time would impose an undue hardship that could not reasonably have been avoided. Requests to accommodate a student's religious creed by scheduling tests or examinations at alternative times should be submitted directly to the faculty member responsible for administering the examination by the second week of the semester.

Reasonable common sense, judgment and the pursuit of mutual goodwill should result in the positive resolution of scheduling conflicts. The regular campus appeals process applies if a mutually satisfactory arrangement cannot be achieved.

The link to this policy is available in the [Religious Creed](#) section of the Academic Calendar webpage.

2. CONFLICTS BETWEEN EXTRACURRICULAR ACTIVITIES AND ACADEMIC REQUIREMENTS

The Academic Senate has established Guidelines Concerning Scheduling Conflicts with Academic Requirements to address the issue of conflicts that arise between extracurricular activities and academic requirements. These policies specifically concern the schedules of student athletes, student musicians, those with out-of-town interviews, and other students with activities (e.g., classes missed as the result of religious holy days) that compete with academic obligations.

These policies were updated in Spring 2014 to include the following statement:

-The pedagogical needs of the class are the key criteria when deciding whether a proposed accommodation is appropriate. Faculty must clearly articulate the specific pedagogical reasons that prevent accepting a proposed accommodation. Absent such a reason, the presumption should be that accommodations are to be made.

The guidelines assign responsibilities as follows:

-It is the instructor's responsibility to give students a schedule, available on the syllabus in the first week of instruction, of all class sessions, exams, tests, project deadlines, field trips, and any other required class activities.

-It is the student's responsibility to notify the instructor(s) in writing by the second week of the semester of any potential conflict(s) and to recommend a solution, with the understanding that an earlier deadline or date of examination may be the most practicable solution.

-It is the student's responsibility to inform him/herself about material missed because of an absence, whether or not he/she has been formally excused.

The [complete guidelines](#) are available on the Academic Senate website. Additionally, a [checklist](#) to help instructors and students comply with the guidelines is available on the Center for Teaching and Learning website.

3. ABSENCES DUE TO ILLNESS

Instructors are asked to refrain from general requirements for written excuses from medical personnel for absence due to illness. Many healthy people experience a mild-to-moderate illness and recover without the need to seek medical attention. University Health Services does not have the capacity to evaluate such illnesses and provide documentation excusing student absences. However, UHS will continue to provide documentation when a student is being treated by Tang for an illness that necessitates a change in course load or an incomplete.

From time-to-time the Academic Senate has issued guidance concerning missed classes and exams due to illnesses such as influenza advising that students not attend class if they have a fever. Should a student experience repeated absences due to illness, it may be appropriate for the faculty member to ask the student to seek medical advice. The Senate guidelines advise faculty to use flexibility and good judgment in determining whether to excuse missed work, extend deadlines, or substitute an alternative assignment. Only the Committee on Courses of Instruction (COCI) can waive the final exam. However, a department chair can authorize an instructor to offer an alternative format for a final exam (e.g., paper, take-home exam) on a one-time basis (<http://academic-senate.berkeley.edu/committees/coci/toolbox#16>).

4. ACCOMMODATION FOR DISABILITY

Instructors are reminded of their responsibilities for accommodating disabilities in the classroom in the following areas:

- Confidentiality: Information about a student's disability is confidential, and may not be shared with other students.
- Role of Instructor: Course instructors play a critical role in enabling the University to meet its obligation to appropriately accommodate students with disabilities who are registered with the Disabled Students Program (DSP) and who have been issued a Letter of Accommodation.
- Reading Assignments:

o In advance: Because students with print disabilities usually need assistance from the DSP Alternative Media Center, reading materials should be provided well in advance (two or more weeks) before the reading assignment due date.

o Required or Recommended: Always indicate which course readings (including bCourse postings) are either "required" readings, or "recommended."

o Accessible Format: Reading materials (especially bCourse postings) should be provided in an "accessible format," e.g., clearly legible, "clean" (without stray marks, highlighting, or mark-ups), and whenever possible, in a Word Document or word-searchable PDF.

For more information about accommodations for students with disabilities, please contact the Disabled Students Program at [510-642-0518](tel:510-642-0518) or email DSP Director Paul Hippolitus hippolitus@berkeley.edu. For more information about providing reading assignments in an accessible format, please contact Martha Velasquez directly at dspamc@berkeley.edu.

5. ACCOMMODATION FOR PREGNANCY AND PARENTING

In compliance with Title IX of the Education Amendments of 1972, and with the California Education Code, Section 66281.7, it is the official policy of the University of California at Berkeley to not discriminate against or exclude any person on the basis of pregnancy or related conditions, and to provide reasonable accommodations to students as appropriate. Instructors are reminded of their responsibilities for excusing medically necessary absences for pregnancy and related conditions and making reasonable accommodations in the areas of class sessions, exams, tests, project deadlines, field trips, and any other required activities. For graduate students, faculty advisors are reminded of policies regarding parental

leave and the extension of normative time for academic milestones, as set out in the Guide to Graduate Policy.

Reasonable common sense, judgment and the pursuit of mutual goodwill should result in the positive resolution of conflicts. The regular campus appeals process or Title IX complaint process apply if a mutually satisfactory arrangement cannot be achieved. For more information about accommodations for student who are pregnant or parenting, please contact the [Office for the Prevention of Harassment and Discrimination](#) or (specific to graduate students) email the Graduate Division at graddean@berkeley.edu.

6. READING, REVIEW, RECITATION (RRR) WEEK

The Reading, Review, Recitation (RRR) period—which are instructional days—before final exams provides students time to prepare for exams, to work on papers and projects, and to participate in optional review sessions and meetings with instructors. For the coming semesters, please keep these dates in mind:

In Fall 2015, formal classes end on Friday, December 4, 2015. RRR Week will take place between the last day of classes (December 4) and the first day of the final exam period (Monday, December 14, 2015). In Spring 2016, classes end on Friday, April 29, 2016. RRR week will take place between the last day of classes (April 29) and the first day of the final exam period (Monday, May 9, 2016).

Please note that the regular semester classroom will NOT be available during the RRR week unless the instructor requests it through the departmental scheduler.

Presentations of capstone projects, oral presentations, and performances are permitted, although flexibility in scheduling may be required to accommodate students' individual schedules. The introduction of new material is not permitted. Mandatory exams or quizzes and other mandatory activities are also not permitted, with some very limited exceptions (capstone presentations, for example).

Please keep in mind that final exams and papers or projects substituting for final exams may not be due before the final exam week.

Detailed, updated [guidelines on RRR week activities](#) are available on the Academic Senate web site. The Office of the Registrar has posted answers to [frequently-asked questions](#) about the academic calendar.

In addition, the Center for Teaching and Learning has prepared some [suggestions on making RRR week productive](#) for instructors and students. If you have tips or ideas you would like to have added to this page, please email teaching@berkeley.edu.

7. COMMENCEMENT CEREMONIES AND FINAL EXAMS

Campus policy stipulates that graduation ceremonies must take place after the conclusion of final examinations, with the exception of professional school ceremonies with graduate students only.

For Fall 2015, final exams end at 10pm on Friday, December 18, 2015

For Spring 2016, final exams end at 10 pm on Friday, May 12, 2016.

The Spring 2016 Graduates Convocation will be held Saturday May 13, 2016. For more information, please see the [Commencement Convocation Events Office website](#).

If you have additional questions, please contact vcue@berkeley.edu.

Syllabus

No.	Date	Topic	Reading
L01	Aug. 26, W	Intro; Definitions	
L02	Aug. 28, F	Ideal gases; Phases & Components; Path vs. State	O 1.2, 1.12
L03	Aug. 31, M	Energy; Heat & Work; 1 st Law	O 1.8; G 2.2 & 2.3
	Sep. 1, Tu	<i>Discussion section</i>	
L04	Sep. 2, W	Flow & shaft work; 1 st Law for open systems	O 4.4.1
L05	Sep. 4, F	Kinetic theory of ideal monatomic gas; C_v and C_p	H; O 6.4.2 (1 st part)
	Sep. 7, M	Holiday	
L06	Sep. 8, Tu	Adiabatic compression of MA gas	O 2.4
L07	Sep. 9, W	Expansion of MA Gas: adiabatic, ∞ , isothermal	
L08	Sep. 11, F	Reversible & irreversible; P.E. in compressed gas	
	Sep. 14, M	<i>Discussion section (Mini-lecture on mathematics)</i>	O 6.1
	Sep. 15, Tu	<i>Discussion section</i>	
L09	Sep. 16, W	MA gas adiabatic tracks; ΔS_{rev}	
L10	Sep. 18, F	Boltzmann's Eq.; 3 rd Law; S as f(U,V)	O 1.6.4.4
L11	Sep. 21, M	ΔS of irreversible process; 2 nd Law; Clausius ineq.	O 1.9, 6.4.2
L12	Sep. 22, Tu	"Iso" processes for closed and open systems	O 3.1–3.5
	Sep. 23, W	<i>Discussion section</i>	
E1	Sep. 25, F	1st Examination on L1–L12	
L13	Sep. 28, M	Aux. props.; Fundamental Diffs.; Maxwell's Rel.	O 1.6, 1.10, 6.2
	Sep. 29, Tu	<i>Discussion section</i>	
L14	Sep. 30, W	Forms of 2 nd Law; Carnot cycle; Exergy	O 4.1–4.4; M 7.2
L15	Oct. 2, F	Brayton cycle (heat engines)	O 4.5.2; M 9.5, 9.6
L16	Oct. 5, M	Polyat. ideal gas; Real gas; Z; Virial & VdW EOS	O 2.3-2.4; G8.2-8.5
	Oct. 6, Tu	<i>Discussion section</i>	
L17	Oct. 7, W	Real-gas thermodynamics	O 6.3 & 6.4
L18	Oct. 9, F	Single-phase solids and liquids	O 2.5, 2.7.2, 6.3
L19	Oct. 12, M	Equilibrium	O 1.11; M 14.1.1
	Oct. 13, Tu	<i>Discussion section</i>	
L20	Oct. 14, W	VdW condensation; G/L 2-phase; Phase diagrams	G8.4; O 2.6, 3.7, 5.3
L21	Oct. 16, F	S/L S/S 2-ph.; Clapeyron Eq. for G/L, S/L, & S/S	O 3.7, 5.3&4, 5.7.1&2
L22	Oct. 19, M	Rankine cycle	O 4.5.1
L23	Oct. 20, Tu	Gas mix.; Dalton's Law; ΔS_{mix}	O 7.1, 7.2
	Oct. 21, W	<i>Discussion section</i>	
E2	Oct. 23, F	2nd Examination on L13–L22	
L24	Oct. 26, M	Partial molar properties; Chem. potential	O7.3.1, 7.4 7.8; G8.6; K6.3
	Oct. 27, Tu	<i>Discussion section</i>	
L25	Oct. 28, W	Vapor press.; Triple pt.; Psychrometry; Fugacity	O 5.7.3&4, 5.5; G 8.7
L26	Oct. 30, F	Activity & Act. Coefficient	O 7.5, 7.6, 7.7; G 9
L27	Nov. 2, M	Partial molar props.; ΔK_{mix} ; Gibbs-Helmholtz	G5.11, 9.5-6; O7.3.1, 7.6
	Nov. 3, Tu	<i>Discussion section</i>	
L28	Nov. 4, W	Excess property model; Regular solutions	O 8.3, G 9

L29	Nov. 6, F	Interphase equil. & distribution	O 8.2, 8.3
L30	Nov. 9, M	Binary Phase Diag.—Lever Rule; Ideal, Analytic	O 8.7, 8.4.1
	Nov. 10, Tu	Gas & Vapor Refrigeration; <i>Discussion section</i>	O 4.5.2-4.5.3
	Nov. 11, W	Holiday	
L31	Nov. 13, F	Binary Phase Diag.—Ideal, Graphic; Regular	O 8.5, 8.4.2
L32	Nov. 16, M	Phase Sep.; Eutectic and other phase diagrams	O 8.6
	Nov. 17, Tu	<i>Discussion section</i>	
L33	Nov. 18, W	Chemical reactions; ΔH , ΔS , & ΔG	O 9.1-9.4
L34	Nov. 20, F	Gas-phase reaction equilibria; Equilibrium comp.	O 9.5-9.8
L35	Nov. 23, M	Reactions of gas & cond. phases and of solutions	O 9.9-9.10
	Nov. 24, Tu	<i>Discussion section</i>	
	Nov. 25, W	Holiday	
	Nov. 27, F	Holiday	
L36	Nov. 30, M	Thermochem data; Ellingham; Gases in metals	O 9.11-9.12
L37	Dec. 1, Tu	Electrochemical bonding	O 10.1-10.5
	Dec. 2, W	<i>Discussion section</i>	
E3	Dec. 4, F	3rd Examination on L23–L37	
	Dec. 7, M	Review of 3 rd Exam (usual time & place)	3108 Etch. 10–11 AM
	Dec. 8, Tu	No meeting; RRR week	
	Dec. 9, W	Review for Final Exam (usual time & place)	3108 Etch. 10–11 AM
	Dec. 11, F	<i>Discussion Section</i> (usual time & place)	3108 Etch. 10–11 AM
	Dec. 14, M	Final Exam, 8–11 AM, Location to be assigned.	
	Dec. 15, Tu	Exam Week	
	Dec. 16, W	Exam Week	
	Dec. 18, F	Exam Week	

O = Olander; G = Gaskell (5th ed.); M = Moran & Shapiro (3rd ed.); K = Koretsky (2nd ed.)
H = <http://hyperphysics.phy-astr.gsu.edu/hbase/hph.html>