

# ENGRD 2210 / MAE 2210: Thermodynamics

## Fall 2017

<http://blackboard.cornell.edu/>

Lectures: 9:05-9:55 AM M/W/F, in Olin Hall 155

Recitations: 7:30-8:20 PM M, Upson 142, 146, and 152

or

12:20-1:10 PM T, Upson 202, 206, or 222.

Syllabus, 10/23/17 *check website for updates*

Prof. E. Fisher, Upson 315, 5-8309, [emf4@cornell.edu](mailto:emf4@cornell.edu),

If you need to make an appointment for different office hours with Prof. Fisher, send an e-mail *listing several possible meeting times*.

### *Course Staff*

| Name | NetID | Role                 |
|------|-------|----------------------|
| X    | X     | Teaching Assistant   |
| X    | X     | Teaching Assistant   |
| X    | X     | Recitation Assistant |
| X    | X     | Recitation Assistant |
| X    | X     | Teaching Assistant   |
| X    | X     | Teaching Assistant   |
| X    | X     | Recitation Assistant |
| X    | X     | Teaching Assistant   |
| X    | X     | Teaching Assistant   |
| X    | X     | Teaching Assistant   |
| X    | X     | Recitation Assistant |
| X    | X     | Teaching Assistant   |

*Office Hours* – see online info

### Whom do I contact?

Course content, how to approach homework: Ask on Piazza, or contact any course staff during office hours, or make an appt with Prof. Fisher.

Problems with grading of homework: Turn in regrade requests (with VERY BRIEF written explanation) to X (Netid, preferred) or Prof. Fisher or discuss with either of them, **within one week of return of homework**.

Problems with grading of exam: Explain the problem in writing (a couple of sentences); turn in your explanation and the exam paper to Prof. Fisher, **within one week of return of exam**.

Absence from recitation: X (Netid, Mondays); X (NetID, Tuesdays) Scheduling make-up or special exams: X (Netid)

Problems with group members: discuss in group; discuss with X (Netid)

Late online homework: E-mail Prof. Fisher (EMF4) by 4 PM on the day it will be turned in.

Late homework with late penalty: E-mail X (Netid) by 4 PM on the day it will be turned in

Late homework without late penalty: Email X (Netid) and explain the circumstances (e.g. documented illness, family emergency, or conflicts with religious observances).

***Any sensitive matters can be discussed with Prof. Fisher (EMF4) rather than with a TA, as needed.***

***Course Learning Outcomes:***

Upon completion of this course, students will be able to:

1. Choose an appropriate system and identify interactions between system and surroundings
2. Obtain values of thermodynamic properties for a pure substance in a given state, using table, relations for incompressible substances, and relations for gases.
3. Apply energy and entropy balances in the control mass (closed system) and control volume formulations to the analysis of devices and cycles.

***Course Catalog Description:*** Presents the definitions, concepts, and laws of thermodynamics. Topics considered include applications to ideal and real gases, vapor and gas power systems, refrigeration, and heat pump systems. Examples and problems are related to contemporary aspects of energy, power generation and broader environmental issues.

***Prerequisites:*** MATH 1920 (Calculus for Engineers) and PHYS 1112 (Physics I: Mechanics) or permission of instructor.

***Required materials:***

*Iclicker* or REEF polling subscription (The Iclicker must be registered this semester through blackboard.) For more information, look in the “course info” folder.

*Text: Fundamentals of Engineering Thermodynamics*, 7th Edition, M.J. Moran, H.N. Shapiro, D.D. Boettner, M.B. Bailey, 2011, **or other recent edition of this text.** 6<sup>th</sup> through 8<sup>th</sup> edition, any format, is acceptable.

Thermodynamic software: TEST. Purchase a license (\$6 for one semester). TEST is accessible at: <http://www.thermofluids.net>. We will use this software later in the semester, and you may be able to share a subscription with other students in your homework group. It is not necessary to buy it at the start of class.

***Collaboration and Groups:***

Blackboard “tests” must be done individually. Regular homework will be done in groups.

With the exception of the first homework assignment, you will be assigned to a group of 3 (or rarely 2 or 4) people and will turn in homework with that group. Each group will turn in one copy of the homework, and all members contributing to the problem set will receive the same grade. Unlimited collaboration is allowed within your group, when you are working on the homeworks.

You are allowed to discuss homework problems with classmates outside of the group or with other people, but you must write up each solution only with members of your own group. **You are not allowed to use written or online problem solutions for homework.** If you do so, you will be subject to action under Cornell’s academic integrity code, <http://cuinfo.cornell.edu/Academic/AIC.html>  
If you have any questions, consult Professor Fisher.

Groups are assigned. We expect to assign new groups once or twice during the semester.

**Everyone in the group must contribute to the homework.** We expect groups to discuss how they will collaborate and come to an agreement. At your first meeting, discuss HOW you will communicate with each other and what will happen if a group member stops communicating or stops contributing. If your group runs into problems with how group members contribute, first try to work things out through discussions within the group. Then, if needed, talk with an instructor. As a last resort, after repeated efforts, we will allow people to quit groups and allow groups to “fire” non-contributing members. This option must be discussed fully with an instructor before any action is taken. Instructors may also (rarely) deduct homework credit in cases where some group members are not participating.

Homework groups are not intended just as an efficient way to get your homework done! We expect that group discussions of homework will help you understand the material, and we hope that the discussions will also be fun.

Recommended schedule for work on homework:

*Wednesday:* homework is assigned on blackboard.

*Wednesday through Sunday/Monday:* Work on homework individually; attend office hours as needed. Each group member should attempt to solve ALL problems in the problem set before meeting as a group. Each group member will be assigned specific problems within the problem set to focus on, and to be prepared to present to the group at recitation. If possible, work through a complete solution to your “presentation” problems; if not, come with specific questions you need help with from your group-mates.

*Monday evening or Tuesday Afternoon:* meet with your group members during recitation. Go over each problem; compare approaches and answers. Remember, the recitation is intended as a teaching/learning experience. Do not rush through problems – make sure that everyone in the group is understanding each problem. If you are far enough along, write up the final version of the problem set; otherwise split up the work and agree on responsibilities and on a schedule for assembling *and checking* the final version of the problem set.

*Tuesday and Wednesday:* continued work on the problem set as needed; final assembly.

*Wednesday:* turn in the problem set by 5 PM, use homework slots on the 2nd floor of Upson Hall.

### ***Late work***

Late regular homeworks will receive 75% partial credit if received within 1 business day of the due date (i.e. if they are received by 5 PM on the Thursday following the regular due date of Wednesday), and will receive 60% partial credit if received within 3 business days of the due date (by Monday 5 PM). No credit will be awarded after that time. If you are turning in a late homework, please turn it in to the regular homework box. In order to receive credit for the late regular homeworks, you must e-mail Elvis Cao (XC295) before 4 PM on the day that the homework is to be turned in.

Late online homeworks will receive 75% partial credit if received within 1 business day of the due date, and will receive 60% partial credit if received within 3 business days of the due date.

Exceptions to this policy are limited to documented illness, family emergency, or conflicts with religious observances.

### ***Attendance***

Recitation attendance is important. If you miss recitation, you will lose points explicitly assigned to attendance (4% of course grade) and may also lose points associated with your group's homework or your mastery of the material.

Recitation attendance points are assigned as follows: You will get full credit if you have 2 or fewer unexcused absences. For each recitation missed above the two allowed, you lose 0.5% of the course grade, up to a maximum of 4% of your course grade lost. Valid excuses include: medical excuse as documented by Gannett or other medical office; religious holidays; travel for sports or other official Cornell activity (documented by coach or faculty advisor). Please discuss any absences with X (Netid, for those attending Monday

sections) or X (Netid, for those attending Tuesday sections), preferably in advance of the absence.

Lecture attendance is also important. We will not explicitly take attendance in class, but some iclicker points will be assigned on the basis of participation.

### **SCHEDULE**

Most homeworks are due on Wednesdays at 5 PM. Please turn in homeworks to the homework slots on 2nd floor of Upson Hall.

| Week number   | Week                        | Assignments and exams   |
|---------------|-----------------------------|---|
| 1             | 8/23-8/25                   | No homework; no recitation  |
| 2             | 8/28-9/1                    | No homework; first recitation held  |
|               | 9/4                         | Labor Day. No recitation. Recitation on 9/5 will be held as office hours, open to all.                    |
| 3             | 9/6-9/8                     | Homework 1 due 9/6. THIS IS AN INDIVIDUAL HOMEWORK.   |
| 4             | 9/11-9/15                   | Homework 2 due 9/13   |
| 5             | 9/18-9/22                   | Homework 3 due 9/20   |
| 6             | 9/25-9/29                   | Homework 4 due 9/27   |
| 7             | 10/2-10/6                   | Homework 5 due 10/4   |
|               | 10/9-10/10                  | Fall Break. No recitation   |
| 8             | 10/11-10/13                 | Homework 6 due <b>Friday</b> 10/13 . THIS IS AN INDIVIDUAL HOMEWORK                                       |
| 9             | 10/16-10/20                 | Recitation is optional.<br>FIRST PRELIM 7:30-9:30 PM Tuesday 10/17, URHG01 (Uris Hall G01??)              |
| 10            | 10/23-10/27                 | Homework 7 due 10/25  |
| 11            | 10/30-11/3                  | Homework 8 due 11/1   |
| 12            | 11/6-11/10                  | Homework 9 due 11/8   |
| 13            | 11/13-11/17                 | SECOND PRELIM 7:30-9:30 PM Tuesday 11/14, Olin Hall 155 (last name A-M) and Olin Hall 255 (last name N-Z) |
| 14            | 11/20-11/21                 | No homework. Recitation will be held as office hours.   |
|               | 11/22-11/26                 | Thanksgiving break  |
| 15            | 11/27-12/1                  | Homework 10 due <b>Friday</b> 12/1  |
| Finals period | Finals period<br>12/6-12/14 | <b>The exact date and time of the final exam will be determined after add/drop period.</b>                |

| Week number;<br>start date | Topics   | Tentative Reading Assignments, 7 <sup>th</sup> Edition<br>(check website for updates)    |
|----------------------------|--|--|
| <b>1</b><br>8/23*          | Introduction;<br>Systems, interactions, and properties   | 1.1-1.9  |
| <b>2</b><br>8/28           | Properties and process variables;<br>Types of energy & energy transfer; energy, 1 <sup>st</sup> law for closed systems | 2.1-2.5  |
| <b>3</b><br>9/6*           | Thermodynamic cycles, evaluating properties  | 2.6-2.7, 3.1-3.8   |
| <b>4</b><br>9/11           | Evaluating properties  | 3.10-3.15 (skim 3.11); TEST software "My First TEST Solution" tutorial (thermo.sdsu.edu) |
| <b>5</b><br>9/18           | Mass conservation for control volumes.<br>First Law for control volumes;   | 4.1-4.3<br>4.4-4.5   |
| <b>6</b><br>9/25           | Steady flow devices  | 4.6-4.12   |
| <b>7</b><br>10/2           | Transient analysis   | 4.12, 5.1-5.4  |
| <b>8</b><br>10/11*         | 2 <sup>nd</sup> law, carnot cycle  | 5.5-5.11 (skip 5.8.2 and 5.8.3)  |
| <b>9</b><br>10/16          | 2 <sup>nd</sup> law, carnot cycle; Clausius inequality;<br>entropy   | 6.1-6.2  |
| <b>10</b><br>10/23         | Entropy balance; Tds relations; isentropic processes; isentropic efficiencies  | 6.3-6.11   |
| <b>11</b><br>10/30         | Isentropic efficiencies; internally reversible steady flow processes; Rankine Cycle                                    | 6.12-6.13; 8.1-8.3   |
| <b>12</b><br>11/6          | Brayton cycle, aircraft engines, <b>combined cycles compressible flow</b>  | 9.5-9.6, 9.9-9.10  |
| <b>13</b><br>11/13         | <del>Compressible flow</del> , IC engines, Otto and diesel cycles  | <del>9.14</del> ; 9.1-9.4  |
| <b>14</b><br>11/20*        | Refrigeration  | 10.1-10.2  |
| <b>15</b><br>11/27         | <del>Combustion</del> —Combustion is not covered.  | <del>13.1-13.3</del>   |



## ***Grading scheme***

|  |     |
|--|-----|
| Prelims  | 38% |
| Final Exam   | 28% |
| Homeworks  | 20% |
| Clicker questions                                  | 5%  |
| Individual homework Q (“tests” graded on computer) | 4%  |
| Attending recitation                               | 4%  |
| Completing SEMESTER-END course evaluations         | 1%  |

Up to 2% boost in final numerical grade may be awarded at the instructor’s discretion, based on participation, effort, improvement, “good citizenship” as a team member, and helpfulness on Piazza.

The lowest “test” (individual homework) score will be dropped.

### *Letter grades:*

If your course numerical grade is 70 or above, you will get a grade of C- or better.

If your course numerical grade is 80 or above, you will get a grade of B- or better.

If your course numerical grade is 90 or above, you will get a grade of A- or better.

### **About iclickers**

We will be using iclickers or mobile devices with the REEF polling app in class this semester. Research has shown that using systems that permit all students to respond to questions in class increases student learning and can provide insight on how students are understanding material in real time. If you have an iclicker from a previous semester you can use it again in this course. Otherwise you will need to get one, either new or used, or else subscribe to REEF polling. You will need to register your iclicker this semester on Blackboard. Please bring your i-clicker to class every day. Graded clicker questions will receive 60% for participation and 40% for a correct answer. Some clicker questions will be ungraded and will be announced as such.

### **Piazza and blackboard.**

We will use blackboard to post homeworks and announcements. We will use Piazza to answer your questions. Students can also help answer questions. There is a link to Piazza the “course info” folder of blackboard. Please sign up.