

CLIMATE/SPACE/EARTH 350 W21

Lecture time: 10am-12pm T/Th

Zoom link: <https://umich.zoom.us/j/96473563243>

Meeting ID: 964 7356 3243

Passcode: 654242

Lecturer: Xianglei Huang (1533 SRB) Tel: 936-0491 Email: xianglei@umich.edu

Office hour: TBD

Mid-term: take-home exam, February 23rd, Tuesday

Final: take-home exam, time TBD

Course description

Fundamentals of thermodynamics are presented, including the First, Second, and Third Laws of thermodynamics. Other topics to be covered are the ideal gas law, adiabatic processes, phase changes and multi-phase system, atmospheric stability. Also included is a heuristic perspective of the gas kinetic theory pertinent to atmospheric phenomenology in general.

The emphasis will be on understanding the concepts and physical laws in thermodynamics, and how to use such knowledge to explain phenomena in the real world. The key skillsets to acquire, in addition to the understanding of the physics of thermodynamics, are (1) order-of-magnitude estimation, (2) dimensional analysis, (3) relating mathematical equations with physical interpretations.

Textbooks

1. Atmospheric Thermodynamics: elementary physics and chemistry / Gerald R. North and Tatiana L. Erukhimova. Cambridge University Press, 2009

The entire book is freely available for the UM readers via

<https://www-cambridge-org.proxy.lib.umich.edu/core/books/atmospheric-thermodynamics/C5B7EA95A767B37B179F3A58AD5A01E1>

*This link should be working from anywhere, but your unique name and password will be required for access.

Required Reading materials

2. Chapter 3 in Atmospheric Science: An Introductory Survey / Michael Wallace and Peter Hobbs

<https://www-cambridge-org.proxy.lib.umich.edu/core/books/atmospheric-thermodynamics/C5B7EA95A767B37B179F3A58AD5A01E1>

A copy of Chapter 3 PDF is also available on Canvas

Optional Reading materials

3. Thermodynamics of Atmospheres and Oceans / Judith A. Curry and Peter J. Webster

<https://www-sciencedirect-com.proxy.lib.umich.edu/bookseries/international-geophysics/vol/65>

4. Chapters 2-7 in Fundamentals of atmospheric physics / Murry L. Salby

<https://www-sciencedirect-com.proxy.lib.umich.edu/bookseries/international-geophysics/vol/61>

Learning Objectives

From minimum to maximum, the goals are:

1. **Know the jargons, perform educated guess:** understand basic concepts, fundamental physical laws, perform orders of magnitude estimates
- 2a. **Know the “drills”:** be able to use the equations and formulas to quantitatively solve related problem
- 2b. **Know the big pictures:** The role played by thermodynamics in the **atmospheres** and its interaction with other components
3. **Know the frontiers:** understand contemporary issues and challenges in 2a & 2b

Skill Development Objectives

1. Apply the knowledge to qualitatively interpret relevant phenomena
2. Develop “physical intuition”: Scaling analysis, order-of-magnitude estimate, dimensional analysis
3. Cultivate ability of quick learning (from “blocks” to “big pictures”)
4. “Math in the physics”: First physics, then express it in math

Lecturing Schedule (tentative)

I: [3-4 hours]

Logistics and course policy. Overview of thermodynamics. Chapter 1: relevant physical concepts and units. Dimensional analysis, scaling analysis, and order of magnitude estimation

II: [3-4 hours]

Chapter 2: Ideal gas law, description of a gaseous system

III: [5-6 hours]

Chapter 3: The First Law of thermodynamics and its application, basics about the adiabatic process

IV: [5-6 hours]

Chapter 4: The Second Law of thermodynamics and its application, the Third Law of thermodynamics

V: [5-6 hours]

Chapter 5: Air and water, multiple-phase systems, Clausius-Clapeyron equation

VI: [4-5 hours]

Chapter 6: 1-dimensional atmosphere vertical profile, dry and moist static energy

VII: [3-4 hours]

Chapter 7: thermodynamic charts, stability analysis, convection

VIII: [2-3 hours]

Chapter 9: thermodynamic equations. Open topics related to atmospheric thermodynamics.

Course Policy and Information

a) Grading: 50% problem sets; 15% mid-term; 15% final; 15% short essay; 5% class performance.

Numeric-to-Letter Grade Conversion available on Canvas and copied below.

Grading Standard:

- “B” designates expected “average” work
- “A-” designates expected “good” work
- “A+” designates truly “excellent” work

b) Exams: both fix-time open-book exams.

c) Short Essay: write a short essay to explain either a phenomenon or a term/jargon used in your field **with relevance to thermodynamics learned in the class.**

Requirements:

(1). No more than three paragraphs (references excluded). **In total everything must fit into one letter-size page with a font size no less than 11.**

(2). Clearly yet succinctly describe the phenomenon or term. You can treat it as if you were asked to write an extended item for a glossary (e.g.

http://glossary.ametsoc.org/wiki/Main_Page)

(3). Your explanation of the phenomenon or term **must have** relevance to the knowledge discussed in the class.

(4). It is not encouraged to choose a term that has been fully explained in the class.

Timeline: (1) By **March 11th**, please email me which term/phenomenon you are to write about. I will compile a list and, if necessary, coordinate with you to avoid duplicated topics.

(2) The short essay will be due on **April 21st** with electronic submission.

(3) If you want feedback from me for your draft essay, please email me no later than **April 15th**.

Grading standards: Relevance to the class (20%); clarity of the writing (40%); technical completeness and correctness (40%).

I will provide more detailed rubrics for this grading as it is close to the end of the semester. In my view, it is crucial for you to learn to communicate your ideas effectively, correctly, and clearly in writing. Most people find writing much more difficult than talking. Although I may know what you're trying to express because I have heard you discuss your ideas during class or during office hours, **I will evaluate your written work on the basis of how well and how correctly the words on the page communicate your ideas.** Developing such writing skills will help you to succeed in your remaining classes, in graduate or professional school, and in the workplace.

d) COVID-related complexities

If you are impacted by COVID-related complexities, i.e., quarantine due to close contact, test positive, or developing COVID-like symptoms, please let me know as soon as you can so we can make arrangements accordingly. **The homework and attendance policies described below are not directly applicable to the COVID-related complexities. The arrangements will be case by case.**

e) Homework

Weekly (occasionally bi-weekly) homework, normally due on Tuesday. No homework is due in the exam weeks.

Late homework policy: **For the fairness of all students**, generally no grade for late homework as time management is also a key skill to acquire in college. Under exceptional and justifiable circumstances, an extension can be granted. **Request with enough justification for such extension must be sent to the lecturer at least 24 hours before the due time, and it is up to the lecturer to approve it or not.** Once approved, the extension is usually no more than one week.

Homework is always before the start of the lecture, not by midnight of the day.

f) **Collaboration policy:**

1) You can discuss and collaborate with classmates or whomever you want. **However, for every word/derivation/calculation, every line of code, and every plot in the homework that you turn in, they MUST be from your own.**

2) **Borrowing problem solutions or graded homework from students attending the previous CLIMATE350 is a direct violation of the Honor Code.** An honor code pledge has to be signed and attached with each homework submission.

3) Directly “Copy & Paste” sentences from websites (e.g., Google, yahoo, wiki) or other sources is **NOT** tolerated and **IS** a violation of the Honor Code.

4) If any of the above is violated, according to the Honor Code, it directly goes to the Honor Code Committee and will be up to their decision.

g) **Attendance policy**

It is expected that students attend all lectures. If you are to miss lectures for legitimate reasons, please try your best to notify me in advance.

- Close engagement with the reading assignments, lectures, and in-class discussion and exercise are all crucial parts of learning. Therefore, attending class is critical for your own success and for the success of the course.
- I will excuse your absence if you bring me a note from a doctor or health professional, a signed letter from a University team or program, or documentation of a family emergency.
- You may miss **two** class sessions without penalty.
- Once you have reached your limit of two unexcused absences, I will lower your class performance by 10% for each additional absence.
- If you miss a class, please watch the recorded lectures. I can also be of help during office hours for such a make-up effort.

h) **Office hours**

The time for office hours will be decided at the first class. The goal is to find a 1-2 hours slot per week that everyone is available, at least for part of it. I understand your daily schedule might change during the semester. **If your schedule does change in the middle of the semester, leading a conflict with the office hour, please email me so we can arrange another time to meet individually and discuss course-related questions that you have.**

i) **Religious Observances**

If a class session or due date conflicts with your religious holidays, please notify me so that we can make alternative arrangements. In accordance with UM policy on religious/academic conflicts, your absence will not affect your grade in the course.

j) Participation

- The success of our course depends on each of you being prepared to participate.
- I will post lecture slides and reading assignments ahead of the lecture time. Reading assignments are usually listed at the end of each PowerPoint file.
- Given the nature of radiative transfer, I especially encourage participation regarding the clarification of concepts and physical laws (the “muddy” points). Besides asking questions, you can also offer your comments and reflections, and share your own observations and insights!
- Code of participation: A positive learning environment relies upon creating an atmosphere where diverse perspectives can be expressed.
 - Respect others' rights to hold opinions and beliefs that differ from your own. Challenge or criticize the idea, not the person.
 - Listen carefully to what others are saying even when you disagree with what is being said. Comments that you make (asking for clarification, sharing critiques, expanding on a point, etc.) should reflect that you have paid attention to the speaker's comments.
 - Be courteous. Don't interrupt or engage in private conversations while others are speaking.
 - Support your statements. Use evidence and provide a rationale for your points.
 - Allow everyone the chance to speak. If you have much to say, try to hold back a bit; if you are hesitant to speak, look for opportunities to contribute to the discussion.
 - If you are offended by something or think someone else might be, speak up and don't leave it for someone else to have to respond to.

k) Cell Phones, Electronic Devices, and Laptops

- Please be sure to put your cell phones away before class begins, unless you expect a call during class (e.g. family emergency). It will be distracting for all of us if you text or use an electronic device during class.
- If you are used to taking notes on your iPad/laptops in the course of lecturing, you are welcome to use them. Otherwise, I will ask that you refrain from using your laptop or iPad for other purposes in class.

Other Information

a) Accommodations for Special Needs

The University of Michigan is committed to ensuring the full participation of all students, and I am committed to making learning as accessible as possible for all students. If you have a disability and need accommodation to participate in this class or to complete course requirements, please ask Services for Students with Disabilities (SSD) to provide documentation of the accommodations that you need. Then, please share this documentation with me as soon as

possible, **preferably within the first few weeks of class**. I will treat as private and confidential any information that you share.

If you suspect that you may have a disability and would like to be tested, Services for Students with Disabilities can provide free screenings and referrals to low-cost diagnostic services.

Here is the contact information for Services for Students with Disabilities:

- Location: G-664 Haven Hall
- Phone: 734-763-3000
- Website: <http://ssp.umich.edu/>

b) Mental Health Resources

1) As a student, you may experience challenges that negatively affect your learning, such as anxiety, depression, interpersonal or sexual violence, difficulty with eating or sleeping, grief/loss, and alcohol or drug problems. The University of Michigan offers several confidential services that you might find helpful for addressing such challenges, including

- Counseling and Psychological Services (CAPS): 734-764-8312
- Sexual Assault Prevention and Awareness Center (SAPAC) 24-Hour Crisis Line: 734-936-3333
- Psychiatric Emergency Services: 734-996-4747.

2) If you have a diagnosed mental health condition, you may also be able to register with Services for Students with Disabilities: see

<http://ssd.umich.edu/mental-health-conditions>.

c) Sweetland Center for Writing

1) The Sweetland Center for Writing-located at 1310 North Quad-is a wonderful and free resource! If you would like additional feedback or assistance as you're planning, drafting, or revising your writing assignments, you can schedule an individual appointment with a Sweetland faculty member, drop in for a peer-tutoring session, correspond online with a peer tutor, or submit your work online to receive feedback within 72 hours.

2) Sweetland faculty members and peer tutors will not edit or but they can assist you with understanding assignments, generating ideas, developing and organizing arguments, using evidence and sources, and clarifying your writing.

3) For more information, please visit:

<http://www.lsa.umich.edu/sweetland/undergraduate>

d) Plagiarism

“Plagiarism is one of the worst academic sins, for the plagiarist destroys the trust among colleagues without which research cannot be safely communicated.”

- Building on others' words and ideas is an essential element of effective scholarship. However, **we must give credit to those whose words and ideas we incorporate into our writing.** Using someone else's words, ideas, or work without proper attribution is plagiarism, and such an act is considered a serious ethical violation within the university community.
- If you complete an assignment for one course and then submit that same assignment as original work for a different course, you are also committing plagiarism.
- Direct copy and paste from the website are also plagiarism.
- If you have additional questions about how to reference material that you find in books or online, please let me know.
- If you commit an act of academic dishonesty in this course either by plagiarizing someone's work or by allowing your own work to be misused by another person, you will face the following consequences:
- I will forward your case, with an explanatory letter and all pertinent materials, to the CoE honor code committee.
- Once the case is forwarded, the committee will be responsible for hearing and determine an appropriate penalty. You may fail the assignment and the course.