

**MCEN 5161 Aerosols - Spring 2022**  
**Instructor: Marina Vance**  
**Department of Mechanical Engineering**  
**Last Updated: 6-Oct-2021**

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**Lecture:** Mondays, Wednesdays, Fridays, 11:15 am - 12:05 pm

**Location:** Zoom, synchronous. See details on Canvas Zoom tool (requires CU Boulder authentication to join). Lecture recordings will be made available to students. We may arrange for some in-person activities throughout the semester if all students are in town.

**Office Hours:** Wednesdays, 9 - 11 am. **In person when Dr. Vance is in Boulder, via Zoom when she is traveling (she will notify via Slack).**

**Slack channel** for course announcements, questions, and student-to-student communication (link expires by **XXX Date**):

**Slack Link**

Use Slack to:

- Communicate with other students in this class and the professor.
- Ask clarifying questions about homework and other course material, which can be answered by other students as well as the professor.
- Chat about project ideas, equipment and software, or other class-related topics.

The professor will only check Slack occasionally, so please do not expect instant turnaround.

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## REQUIRED TEXTBOOK

Hinds, W.C. Aerosol Technology: Properties, Behavior, and and Measurements of Airborne Particles, 2nd edition, Wiley, 1999.

### ***Additional suggested material:***

Seinfeld, J. H. and S. N Pandis, Atmospheric Chemistry and Physics: From Air Pollution to Climate Change, 2nd edition, Wiley, 2006.

Other materials to be provided by the professor during the semester.

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## COURSE DESCRIPTION

Aerosols (solid/liquid particles suspended in a gas) are ubiquitous. They come in many forms, often described as dust, fume, mist, smoke, smog, or fog and they can affect visibility, climate, as well as our health and quality of life. Understanding the aerosol properties enables us to comprehend the production, transport, and fate of atmospheric particulate pollutants. This course covers physical properties, behavior, and measurement and sampling of aerosols. This course introduces atmospheric aerosols and properties of their distributions, followed by fundamental descriptions of single particle dynamics and populations dynamics. Particle sampling, respiratory deposition, thermodynamics, electrical and optical properties are also covered.

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## LEARNING OBJECTIVES

Upon successful completion of this course, you should be able to demonstrate:

- Familiarity with characteristics of aerosols
  - Understanding of particle size distributions
  - Ability to quantitatively describe particle deposition processes
  - Ability to quantitatively describe fundamentals of particle motion
  - Familiarity with light scattering and visibility impairment
  - Understanding of particle measurement and experimental methods
  - Ability to quantitatively describe particle-particle and particle-gas interactions
  - Familiarity with respiratory tract deposition
  - Understanding of the health effects of particles
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## GRADING:

- Homework: 25%
- Exams: 25%
- Final project: 40%
- Aerosol video: 5%
- Participation and professionalism 5%

### The breakdown of the final grade is:

A	93 - 100
A-	90 - 93
B+	87 - 90
B	83 - 87
B-	80 - 83
C+	77 - 80
C	73 - 77
C-	70 - 73
D+	67 - 70
D	63 - 67
D-	60 - 63
F	< 60

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**Homework:**

There will be **six homework assignments** throughout the semester. Solutions will be posted to Canvas after the homework has been submitted. **The lowest homework grade will be dropped.** In order to receive full credit on homework assignments you must follow the guidelines listed below. These guidelines will improve/reiterate organizational skills and facilitate homework grading:

- Turn the homework in on time. Late submissions will not be graded.
- Each problem should begin on a new page and the problem number must be indicated. Pages should be numbered. Type or hand-write neatly and show all work.
- Present your homework solution in a cohesive manner that describes your process. Include important figures/results in the body of the document and save things like code for an appendix. Make your final answers explicit (e.g., box the final answer) to help the grader.
- The assignment should be compiled into a single PDF and must be legible. Assignments that are not legible will receive a score of zero. Instructions for scanning assignments with your phone: Using [Android \(Links to an external site.\)](#) and [iPhone \(Links to an external site.\)](#).
- All homework will be submitted via Gradescope.

**Exams:**

We will have **three midterm exams** which will consist of problems related to lecture topics. The exams are open-book, open-notes and will be held remotely (take-home). Students will have roughly 30 hours to complete each exam. They will be posted on Thursday evening (6 pm) and will be due before midnight on Friday. There will be no class on exam day.

All guidelines for Homework submission also apply to Exams.

Please make me aware of any scheduling conflicts with an exam as soon as possible. Proper documentation will be required. There will be no make-up exam. If an exam is missed due to a justifiable issue, the weights of other exams will change to make up for the missed exam.

**Final Project:**

**This class will have one final project that will encompass multiple stages:**

- **Introductory presentation**
- **Final project presentation**
- **Final project report**

**Depending on the class size and composition, the final project may be individual or in small teams.**

**Aerosol Video:**

Students are required to create one short (1-5 min) video explaining one concept related to aerosols to a broad audience. The video topic must be approved by the professor before a video is created. There will be video preparation guidelines and advice discussed in class. Videos will be posted publicly to YouTube for posterity.

**Participation and professionalism:**

Your professionalism grade depends on your in-classroom behavior (online or in-person), overall participation, responsiveness to messages, prompt and effective communication with the professor and colleagues, etc.

**Regrading:**

The professor will handle all grading disputes. Any request for a grade change should be made within one week after the work is graded. You must write a comment on the Gradescope assignment describing where and why you are disputing the grade. The entire submission will be subject to regrading, which can go up or down in score. Expect one week for each grade dispute evaluation.

**Tips for success:**

- Attend classes, take notes, actively participate in in-class examples and discussions.
- Read the course announcements.
- Do not miss a homework just because that grade will be dropped.

**Communication with the professor:** I am very willing to assist with your academic needs outside of the classroom. Multiple professional obligations, however, make it necessary for me to schedule my availability. Please respect posted office hours and avoid disrupting meetings. To contact the professor, please send an email or Slack message.

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**COUSE SCHEDULE (PRELIMINARY – SUBJECT TO CHANGE)**

Week	Date	Class	Class Topic	Reading	Other activities	Deliverables
1	Mon, 10-Jan	1	Intro to course	Syllabus		
	Wed, 12-Jan	2	Intro to aerosols	Ch 1		
	Fri, 14-Jan	3	Aerosol video intro			
Mon, 17-Jan						
2	Wed, 19-Jan	4	Properties of Gases	Ch 2 (p 15-31)		
	Fri, 21-Jan	5	cont'd		HW1 posted	
3	Mon, 24-Jan	6	Uniform Particle Motion	Ch 3 (p 42-55)		
	Wed, 26-Jan	7	cont'd	App 3.10 pp 67-70		
	Fri, 28-Jan	8	Problem solving session			
4	Mon, 31-Jan	9	Particle size distributions	Ch 4 (p 75-82)		HW 1 due
	Wed, 2-Feb	10	cont'd			
	Fri, 4-Feb	11	Project idea approval		HW 2 posted	
5	Mon, 7-Feb	12	Particle Acceleration and curvilinear motion	Ch 5		
	Wed, 9-Feb	13	cont'd			
	Fri, 11-Feb	14	Brownian motion and diffusion	Ch 7		
6	Mon, 14-Feb	15	Filtration	Ch 9		HW 2 due
	Wed, 16-Feb	16	Problem solving session			
	Fri, 18-Feb	17	<b>EXAM 1 - No class</b>		HW3 posted	
7	Mon, 21-Feb	18	Sampling	Ch 10		
	Wed, 23-Feb	19	cont'd			
	Fri, 25-Feb	20	Aerosol video theme discussion and decisions			
8	Mon, 28-Feb	21	Optical properties	Ch 16		HW 3 due
	Wed, 2-Mar	22	cont'd			
	Fri, 4-Mar	23	Low cost sensors		HW 4 posted	
9	Mon, 7-Mar	24	Introductory presentation			
	Wed, 9-Mar	25	Introductory presentation			
	Fri, 11-Mar	26	Introductory presentation			
10	Mon, 14-Mar	27	Electrical properties	Ch 15		HW 4 due
	Wed, 16-Mar	28	cont'd			
	Fri, 18-Mar	29	<b>EXAM 2 - No class</b>			
Mon, 21-Mar						
Wed, 23-Mar						
Fri, 25-Mar						

11	Mon, 28-Mar	30	Respiratory deposition	Ch 11	HW 5 posted
	Wed, 30-Mar	31	cont'd		
	Fri, 1-Apr	32	Final project check-in		
12	Mon, 4-Apr	33	Coagulation	Ch 12	HW 5 due
	Wed, 6-Apr	34	cont'd		
	Fri, 8-Apr	35	Problem solving session		
13	Mon, 11-Apr	36	Condensation and Evaporation	Ch 13	HW 6 posted
	Wed, 13-Apr	37	cont'd		
	Fri, 15-Apr	38	Atmospheric Aerosols	Ch 14	Aerosol Video
14	Mon, 18-Apr	39	Video Watching session		HW 6 due
	Wed, 20-Apr	40	<b>EXAM 3 - No class</b>		
	Fri, 22-Apr	41	Final Project Presentation		
15	Mon, 25-Apr	42	Final Project Presentation		
	Wed, 27-Apr	43	Final Project Presentation		Final Proj. Report
	Fri, 29-Apr		Reading Day		
	Finals week		No final		

## COURSE POLICIES

### Remote class expectations

Despite the fact that you may be attending a meeting or class from home or other location, you should treat the remote meeting environment as a professional one. Expectations for class meetings will be different from expectations for smaller group meetings. For smaller group meetings be sure that the whole group understands and is comfortable with the expectations for remote meeting conduct.

**Preparation:** Please use your preferred full name when you join Zoom sessions. Do not use any usernames or “nicknames” that don’t represent your real name. Make the necessary preparations in advance of your online Zoom session. For example, use the restroom and get all of your readings and note-taking materials handy before the session starts.

**Zoom lecture participation:** Choose a location for your Zoom meeting with a good Wi-Fi connection, and that is as free as possible from distractions, both auditory and visual. Keep your camera on if your internet bandwidth allows. Remember that others will see what is located behind you, which may be distracting to them or unflattering to you. If you cannot find a location with a sufficiently professional background, use an appropriate virtual background. If you share space with roommates, siblings, parents, etc., let them know when you will be in meetings to avoid embarrassing or distracting scenarios as much as possible. Set up your camera location and position yourself relative to light sources that allow others to see you clearly. Sit on a chair and use a table or desk for your laptop. Putting your laptop on your lap will jiggle the camera and make people seasick to look at you.

**Appearance:** Please keep your webcam on during Zoom meetings—your digital face is a sign of your presence, just like meeting in person. It makes a huge difference to your colleagues and to the overall “feel” of the meeting. Non-verbal cues in your facial expressions and body language are an important part of communication.

**Engagement and Communication:** Be present. Please be seated at a table or desk and focused solely on class during each session. Please mute yourself when you are not talking to avoid distracting the rest of the class. Be engaged and responsive during the meeting. Don’t be afraid to speak or use chat, especially if the meeting is small. Your feedback and engagement are essential to the communication that takes place in a meeting. For larger meetings, use non-verbal feedback buttons and chat windows to respond to the discussion or make a request of the speaker without disrupting the audio. Remember that chat comments (even “private” chat messages) are public and part of the meeting record, so keep topics relevant and professional.

**Technical Difficulties:** Send the meeting organizer a private chat through the Zoom chat feature (or, if you can’t login, email them) if you have any technical problems. Depending on your meeting size and the organizer, they may or may not be able to help you, so consider other options and resources that may be available in real-time, such as a colleague. If you have an unstable connection, try turning off your video and/or switching to phone audio.

### Classroom behavior

Both students and faculty are responsible for maintaining an appropriate learning environment in all instructional settings, whether in person, remote or online. Those who fail to adhere to such behavioral standards may be subject to discipline. Professional courtesy and sensitivity are especially important with respect to individuals and topics dealing with race, color, national origin, sex, pregnancy, age, disability, creed, religion, sexual orientation, gender identity, gender expression, veteran status, political affiliation or political philosophy. For more information, see the policies on [classroom behavior](#) [Links to an external site.](#) and the [Student Code of Conduct](#) [Links to an external site.](#)

### **Honor code**

All students enrolled in a University of Colorado Boulder course are responsible for knowing and adhering to the Honor Code. Violations of the policy may include plagiarism, cheating, fabrication, lying, bribery, threat, unauthorized access to academic materials, clicker fraud, submitting the same or similar work in more than one course without permission from all course instructors involved, and aiding academic dishonesty. All incidents of academic misconduct will be reported to the Honor Code ([honor@colorado.edu](mailto:honor@colorado.edu)); 303-492-5550). Students found responsible for violating the academic integrity policy will be subject to nonacademic sanctions from the Honor Code as well as academic sanctions from the faculty member. Additional information regarding the Honor Code academic integrity policy can be found at the [Honor Code Office website](#)[Links to an external site.](#).

### **Accommodation for disabilities**

If you qualify for accommodations because of a disability, please submit your accommodation letter from Disability Services to your faculty member in a timely manner so that your needs can be addressed. Disability Services determines accommodations based on documented disabilities in the academic environment. Information on requesting accommodations is located on the [Disability Services website](#)[Links to an external site.](#). Contact Disability Services at 303-492-8671 or [dsinfo@colorado.edu](mailto:dsinfo@colorado.edu) for further assistance. If you have a temporary medical condition, see [Temporary Medical Conditions](#)[Links to an external site.](#) on the Disability Services website.

### **Preferred student names and pronouns**

CU Boulder recognizes that students' legal information doesn't always align with how they identify. Students may update their preferred names and pronouns via the student portal; those preferred names and pronouns are listed on instructors' class rosters. In the absence of such updates, the name that appears on the class roster is the student's legal name. I will gladly honor your request to address you by an alternate name or gender pronoun. Please advise me of this preference early in the semester so that I may make appropriate changes to my records.

### **Sexual misconduct, discrimination, harassment and/or related retaliation**

The University of Colorado Boulder (CU Boulder) is committed to fostering an inclusive and welcoming learning, working, and living environment. CU Boulder will not tolerate acts of sexual misconduct (harassment, exploitation, and assault), intimate partner violence (dating or domestic violence), stalking, or protected-class discrimination or harassment by members of our community. Individuals who believe they have been subject to misconduct or retaliatory actions for reporting a concern should contact the Office of Institutional Equity and Compliance (OIEC) at 303-492-2127 or [cureport@colorado.edu](mailto:cureport@colorado.edu). Information about the OIEC, university policies, [anonymous reporting](#) ([Links to an external site.](#)), and the campus resources can be found on the [OIEC website](#)[Links to an external site.](#).

Please know that faculty and graduate instructors have a responsibility to inform OIEC when made aware of incidents of sexual misconduct, dating and domestic violence, stalking, discrimination, harassment and/or related retaliation, to ensure that individuals impacted receive information about options for reporting and support resources.

### **Racist language, behavior, and discrimination**

The ME department holds students, faculty, and staff accountable for racist comments and behavior, whether intentional or unintentional. We expect members of our community to take responsibility for understanding why some comments and actions may be racist and actively eliminating language and behaviors that perpetuate racial inequities. More information is available at [An Antiracist CU](#) ([Links to an external site.](#)).



## Discrimination and harassment

Discriminatory and harassing behavior will not be tolerated in the Department of Mechanical Engineering. A safe and inclusive environment will be created and maintained by the students and instructing faculty member. Students with concerns about discrimination or harassment actions should immediately contact the instructor, the Department Chair or their academic advisor, or the [Office of Institutional Equity and Compliance](#)[Links to an external site.](#)

Examples that may be considered harassment:

- A teaching assistant or instructor asking a student for a date.
- Displaying sexually explicit material in an academic setting (including laptop wallpaper).
- Persisting in asking a classmate for a date after being turned down.
- Using degrading terminology in referring to others, including peers.

## Religious holidays

Campus policy regarding religious observances requires that faculty make every effort to deal reasonably and fairly with all students who, because of religious obligations, have conflicts with scheduled exams, assignments or required attendance. You must make me aware of these conflicts in advance. See the [campus policy regarding religious observances](#)[Links to an external site.](#) for full details.

## Campus COVID-19 syllabus statements

As a matter of public health and safety due to the pandemic, all members of the CU Boulder community and all visitors to campus must follow university, department and building requirements and all public health orders in place to reduce the risk of spreading infectious disease. Students who fail to adhere to these requirements will be asked to leave class, and students who do not leave class when asked or who refuse to comply with these requirements will be referred to [Student Conduct and Conflict Resolution](#)[Links to an external site.](#) For more information, see the policy on [classroom behavior](#)[Links to an external site.](#) and the [Student Code of Conduct](#)[Links to an external site.](#) If you require accommodation because a disability prevents you from fulfilling these safety measures, please follow the steps in the "Accommodation for Disabilities" statement on this syllabus.

As of Aug. 13, 2021, CU Boulder has returned to requiring masks in classrooms and laboratories regardless of vaccination status. This requirement is a temporary precaution during the delta surge to supplement CU Boulder's COVID-19 vaccine requirement. Exemptions include individuals who cannot medically tolerate a face covering, as well as those who are hearing- impaired or otherwise disabled or who are communicating with someone who is hearing- impaired or otherwise disabled and where the ability to see the mouth is essential to communication. If you qualify for a mask-related accommodation, please follow the steps in the "Accommodation for Disabilities" statement on this syllabus. In addition, vaccinated instructional faculty who are engaged in an indoor instructional activity and are separated by at least 6 feet from the nearest person are exempt from wearing masks if they so choose.

Students who have tested positive for COVID-19, have symptoms of COVID-19, or have had close contact with someone who has tested positive for or had symptoms of COVID-19 must stay home. In this class, if you are sick or quarantined, the instructor will not require students to state the nature of their illness due to FERPA student privacy laws. "Doctor's notes" will not be required for classes missed due to illness.