ASEN 6061: Molecular Gas Dynamics and Direct Simulation Monte Carlo

Spring 2025

Time:	Tue./Th. 10:00 – 11:15 AM	**Location:**	AERO N250/Recordings
Instructor:	Prof. Robyn Macdonald	**Email:**	robyn.macdonald@colorado.edu

Course Page: https://canvas.colorado.edu/

Course Slack Channel: Invite Link

Office Hours:

Day	Time	Location
Wednesday		
Friday		

Office Hours Zoom link:

Course Objectives: The objectives of this course are to learn the fundamentals of kinetic theory and molecular gas dynamics. The secondary objective of this course is to learn the fundamentals of the direct simulation Monte Carlo method and to apply it to simple canonical problems.

Text: The required textbook for this course is available online through the CU Boulder Library. If you are having trouble accessing it please ensure you are on the campus WiFi or connected to the campus VPN. You may also need to make an account through Elsevier to access the textbook online which you can link with your CU credentials.

Required Reference:

- Bird, G. A., *Molecular gas dynamics and the direct simulation of gas flows,* Clarendon Press, 1994. Available online: https://app.knovel.com/s.v?ROZjZMPz

Optional References:

- Boyd, I. D., and Schwartzentruber, T. E., *Nonequilibrium Gas Dynamics and Molecular Simulation,* Cambridge University Press, 2017. Available online: https://www.cambridge.org/core/books/nonequilibrium-gas-dynamics-and-molecular-simulation/E317E76AA03C6C2C0A78A utm_campaign=shareaholic&utm_medium=copy_link&utm_source=bookmark
- Ferziger, J. H., and Kaper, H. G., *Mathematical theory of transport processes in gases,* North-Holland Publishing Company, 1972.
- Giovangigli, V., *Multicomponent Flow Modeling,* Springer Science + Business Media, LLC, 1999. Available online: https://link.springer.com/book/10.1007/978-1-4612-1580-6
- Vincenti, W. G., and Kruger, C. H., *Introduction to Physical Gas Dynamics,* Krieger Publishing Company, 1986.

Prerequisites: A first course in gas dynamics, including ASEN 5151 (or instructor approval). I will assume you are familiar with basic concepts of thermodynamics and gas dynamics. I expect students to be proficient with programming which will be used for some assignments and projects.

Grading Policy: Projects (60%), Homework assignments (10%), Quizzes (10%), Exam (20%).

Homework: Homework will be assigned periodically as the appropriate material is covered, and will include both handwritten problem sets and simple programming assignments. The due date for each assignment will be announced when the assignment is made. All students will submit assignments through the course Gradescope website. The late penalty for homework will be 10% per day, for up to 5 days. Beyond 5 days late, the assignment is worth 0%. You may receive help from a classmate or the instructor on homework assignments, but the submitted assignment must be your own work. This includes both handwritten solutions, as well as programming assignments.

Exams: There will be one take home exam in this course. The date will be specified at a later date.

Projects: There will be 2-3 projects in this course that will have you apply concepts and algorithms learned in the course to solve problems related to rarefied gas dynamics. The projects will be assigned such that students have at least one month to complete them and will have the same late penalty policy as the homework assignments.

Quizzes: There will periodically be quizzes assigned through Canvas. Each quiz will cover approximately one chapter of course content. The quizzes will available for several days and students may take the quiz whenever they want within that time period. Further details will be provided before the first quiz.

Class format: This class operates in two modalities: in-person and asynchronous remote. All lectures will be recorded via Classroom Capture and will be made available to all students.

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 Honor Code may include but are not limited to: plagiarism (including use of paper writing services or technology [such as essay bots]), 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. Understanding the course's syllabus is a vital part in adhering to the Honor Code.

All incidents of academic misconduct will be reported to Student Conduct & Conflict Resolution: StudentConduct@colorado.edu. Students found responsible for violating the Honor Code will be assigned resolution outcomes from the Student Conduct & Conflict Resolution as well as be subject to academic sanctions from the faculty member. Visit Honor Code for more information on the academic integrity policy.

Accommodation for Disabilities, Temporary Medical Conditions, and Medical Isolation: 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. Contact Disability Services at 303-492-8671 or DSinfo@colorado.edu for further assistance. If you have a temporary medical condition, see Temporary Medical Conditions on the

Disability Services website.

If you have a temporary illness, injury or required medical isolation for which you require adjustment due to a missed in-person assessment (exam), please alert Professor Macdonald of your absence via email but do not include specific information about your illness due to privacy laws. Because attendance is not required in this class, if you miss a class you do not need to inform Professor Macdonald but can watch the lecture asynchronously on Canvas.

Students should expect to receive accommodations for a timed assessment (e.g., exam) only if their faculty instructor(s) receive the student's accommodations letter at least 5 business days before the assessment, as a departmental policy, in order to facilitate administering the assessment.

Accommodation for Religious Obligations: Campus policy requires faculty to provide reasonable accommodations for students who, because of religious obligations, have conflicts with scheduled exams, assignments or required attendance. Please communicate the need for a religious accommodation in a timely manner. In this class if you must miss an in-class assessment (exam) due to a religious obligation, please contact Professor Macdonald at least two weeks prior to coordinate an accommodation. See the campus policy regarding religious observances for full details.

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.

Classroom Behavior: Students and faculty are responsible for maintaining an appropriate learning environment in all instructional settings, whether in person, remote, or online. Failure 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, marital status, political affiliation, or political philosophy.

For more information, see the classroom behavior policy, the Student Code of Conduct, and the Office of Institutional Equity and Compliance.

Sexual Misconduct, Discrimination, Harassment and/or Related Retaliation: CU Boulder is committed to fostering an inclusive and welcoming learning, working, and living environment. University policy prohibits protected-class discrimination and harassment, sexual misconduct (harassment, exploitation, and assault), intimate partner abuse (dating or domestic violence), stalking, and related retaliation by or against members of our community on- and off-campus. The Office of Institutional Equity and Compliance (OIEC) addresses these concerns, and individuals who have been subjected to misconduct can contact OIEC at 303-492-2127 or email CUreport@colorado.edu. Information about university policies, reporting options, and OIEC support resources including confidential services can be found on the OIEC website.

Please know that faculty and graduate instructors are required to inform OIEC when they are made aware of incidents related to these concerns regardless of when or where something occurred. This is to ensure that individuals impacted receive outreach from OIEC about their options and support resources. To learn more about reporting and support for a variety of concerns, visit the Don't Ignore It page.

Mental Health and Wellness: The University of Colorado Boulder is committed to the well-being

of all students. If you are struggling with personal stressors, mental health or substance use concerns that are impacting academic or daily life, please contact Counseling and Psychiatric Services (CAPS) located in C4C or call (303) 492-2277, 24/7.

Free and unlimited telehealth is also available through Academic Live Care. The Academic Live Care site also provides information about additional wellness services on campus that are available to students.