ASEN 5151: Compressible Flow

Spring 2021

Time:	Mon./Wed./Fri., 12:00 pm – 12:50 pm
In-person location:	AERO N240
Remote location:	Recurring Zoom meeting:
Instructor:	Assistant Professor Robyn Macdonald
	Email: robyn.macdonald@colorado.edu
	Office: AERO 359
	Office hours: TBD
Teaching Assistant:	Basu Parmar
	Email: basu.parmar@colorado.edu
	Office hours: TBD
Website:	Canvas (https://canvas.colorado.edu/)

Recommended textbook: Anderson, J. D., Jr., *Modern Compressible Flow with Historical Perspective,* Fourth Edition, McGraw-Hill, 2020.

Note: The preferred edition of the textbook is the 4th edition as it is the current publication, however, any edition of this text will suffice for this course.

Supplemental references: Additional readings may be recommended from the following books. Any readings assigned will be provided either through the course website or the CU library.

- Liepmann, H. W. and Roshko, A., *Elements of Gasdynamics,* Dover Publications, 2001. Available online: https://tinyurl.com/yb5pux98
- Pletcher, R. H., Tannehill, J. C., and Anderson, D. A., *Computational Fluid Mechanics and Heat Transfer,* Third Edition, CRC Press, 2013. Available online: https://tinyurl.com/y2hjeflc
- Rathakrishnan, E., *Theoretical Aerodynamics,* Wiley, 2013. Available online: https://tinyurl.com/y6tt3sv6
- Shapiro, A. H., *The Dynamics and Thermodynamics of Compressible Fluid Flow,* Vol. I, Ronald Press, 1953. Available online: https://tinyurl.com/yxergkvo
- Thompson, P. A., *Compressible-Fluid Dynamics,* McGraw-Hill, 1988.
- Zucrow, M. J. and Hoffman, J. D., *Gas Dynamics,* Vol. I, Wiley, 1976.
- Zucrow, M. J. and Hoffman, J. D., *Gas Dynamics,* Vol. II, Wiley, 1977.

Prerequisites: A first course in compressible flow, including ASEN 3111. I will assume that you are familiar with typical topics from an introductory compressible flow course, including isentropic flow with area change, Fanno flow, Rayleigh flow, normal shock waves, oblique shock waves, Prandtl-Meyer flow, associated applications such as converging and converging-diverging nozzles, etc. I expect students to have a basic knowledge of programming in MATLAB which will be used for some assignments.

Grading policy: Homework (50%), Exam 1 (25%), Exam 2 (25%).

Homework: Homework will be assigned periodically as the appropriate material is covered, and will include both handwritten problem solutions and computer solutions. The due date for each assignment will be announced when the assignment is made. All students will submit assignments through the course 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/TA on homework assignments, but the submitted assignment must be your own work. This includes both handwritten solutions, as well as programming assignments.

Class format: This class operates in two modalities: hybrid and virtual:

- **Hybrid:** students enrolled in this section should attend class synchronously, either in person or remotely via Zoom. When in person classes are permitted we will alternate groups of students who attend in person classes due to size restrictions of our classroom. I will be in contact via email at a later date to coordinate those groups.
- **Virtual:** students enrolled in this section attend class asynchronously by watching recordings of the lectures on their own time.

All students are permitted to attend the zoom meetings synchronously, and recordings will be made available for all students. Lecture notes and handouts will be posted for each lecture.

Topics (time permitting):

1. Review of Fluid Mechanic and Thermodynamic Principles
2. Generalized One-Dimensional Flow
3. Partial Differential Equations Governing Inviscid Compressible Flow
4. Linearized Flows/Analytical Techniques
5. Supersonic Flow Over a Cone
6. Steady, Two-Dimensional Supersonic Flow
7. Unsteady, One-Dimensional Flow
8. The Time-Dependent Finite-Difference Technique

Spring Pause: The week of March 22-26 will be used in this class as a spring pause to provide us all with a safe and supportive way to promote health, wellness and learning without leaving campus. During this week, we won't have any exams or assignments due. We will still have class with class activities that will require your attendance. While March 25 is a wellness day, attendance is still required for all other class sessions that week. I wish we could take a regular spring break, but public health concerns prevent us from doing so. I would like to emphasize that it is still important for you all to behave responsibly. Do not use the week to travel or engage in risky behavior that could result in an outbreak on campus after we all return.

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 and the Student Code of Conduct.

Requirements for COVID-19: 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 public health orders in place to reduce the risk of spreading infectious disease. Required safety measures at CU Boulder relevant to the classroom setting include:

- maintain 6-foot distancing when possible,

- wear a face covering in public indoor spaces and outdoors while on campus consistent with state and county health orders,
- clean local work area,
- practice hand hygiene,
- follow public health orders, and
- if sick and you live off campus, do not come onto campus (unless instructed by a CU Healthcare professional), or if you live on-campus, please alert CU Boulder Medical Services.

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. For more information, see the policies on COVID-19 Health and Safety and classroom behavior and the Student Code of Conduct. If you require accommodation because a disability prevents you from fulfilling these safety measures, please see the "Accommodation for Disabilities" statement on this syllabus.

All students who are new to campus must complete the COVID-19 Student Health and Expectations Course. Before coming to campus each day, all students are required to complete the Buff Pass. Time will not be provided in class to complete the form.

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, please alert me by email of your absence but do not include specific information about your illness due to privacy laws.

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. 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.

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.

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); 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.

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. Information about the OIEC, university policies, anonymous reporting, and the campus resources can be found on the OIEC website.

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. In this class let my know by email of the conflict, and I will work with you to accommodate.

See the campus policy regarding religious observances for full details.