AE 312
Compressible Flow
Spring 2024
Syllabus Ver. 1.0

Course Description: Dynamics of compressible fluid; conservation of mass, momentum, and energy; one-dimensional and quasi-one-dimensional flow; oblique shock waves & Parandtl-Meyer expansion fans; unsteady wave motion; linearized theory. Application to nozzles, diffusers, airfoils, shock tubes and other geometries.

ME 410: Solution of internal compressible-flow problems by one-dimensional techniques, both steady and unsteady; flows with smooth and abrupt area change, with friction, with heat addition, and with mass addition; flows with weak and strong waves, multiple confined streams, and shock waves.

Course Objectives: Understand the theory behind compressible flow in different problem setups, apply derived solutions and equations to compressible flow problems, understand the assumptions necessary to derive equations and problem formulations. Apply and build upon prerequisite scientific, mathematics, and engineering knowledge to a new theoretical and applied field of study, compressible flow. Apply course material to problems related to engineering design requirements involving compressible fluids. Learn and apply graph reading, comprehension, and construction skills. Learn and apply table reading and comprehension skills. Understand and recall vocabulary necessary to discuss compressible flow as a technical topic. Use vocabulary in engineering design contexts to describe problem setups, steps, and solutions. Experience and practice with in-class quiz time and take-home quiz practice to develop habits and skills to solve problems quickly. Application of all these skills in the time-trial exam formulation to solidify learning. Application of all skills in comprehensive final exam to solidify learning with spaced-repetition strategy. Experience with responsibility in an engineering context to develop strategies and habits for completing work honestly and communicating personal challenges to find solutions.

Course Meeting: MWF 1:00 PM – 1:50 PM 3031 Campus Instructional Facility (CIF)

Instructor: Dr. Elle Wroblewski ("El-lee" "Ro-bleh-ski" or "Vroo-blev-ski" if you're feeling fancy)
wroblew3@illinois.edu
Ph.D. Aerospace Engineering 2022
M.S. Aerospace Engineering 2016
B.S. Aerospace Engineering 2014
my gender is **nonbinary**
my pronouns are **they/them/theirs**
my professional/personal address is **Doctor (Dr) or Professor (Prof)**
please do not use these forms of address refer to me:
Mr., Ms., Mrs., Ma'am, Miss, or "the lady"

Questions: Speak to me before, during, or after class. Speak to me at office hours. Email me with your question. Do not message me through Canvas.

Teaching Assistants: Mac Mack dm49@illinois.edu
Dongjoo Lee edwin5@illinois.edu

Office Hours:	Monday, 10:00 AM – 10:50 AM, Talbot 319n and THIS ZOOM LINK Wednesday, 5:00 PM – 5:50 PM, Talbot 319m and THIS ZOOM LINK You can request an in-person or zoom meeting with me if you cannot make it to office hours, this is subject to my availability during business hours.
Prerequisites:	AE 202 & Math 285, credit or concurrent ME 200 > Math 241, TAM 212 > TAM 210/211 > PHYS 211 & Math 231 > Math 220/221
Credit:	3 Credit Hours
Course Website:	Canvas
Textbook:	Recommended, not required. John D. Anderson Jr. "Modern Compressible Flow with Historical Perspective" the 2nd, 3rd, or 4th editions are fine, 4th is most relevant if you want to pursue hypersonic vehicle engineering. Digital Book Purchase: Modern Compressible Flow: With Historical Perspective 4th edition | 9781260471441, 9781260588774 | VitalSource
Attendance:	Student Code. View the recorded lectures if you cannot attend in-person due to any reason. If you miss class, I will tell you to review the posted notes/videos and read announcements. Do not come to class if you are symptomatic. If you are unwell, facing a struggle, have religious duties, have professional development responsibilities, or have any type of emergency, you can make up missed work ***if you speak to me and/or email me about it.***
"Quizwork":	Quizzes are given weekly. Time in-class is given to work on elements of the problems and the remainder of the work is for homework or office hours. Quizworks are due Monday end-of-day. Solutions will be posted Friday before class. See Quizwork 1 for more information on policies and expectations.
Extensions:	You may request a 3-day extension on any/all Quizwork assignments. This request form is linked on Canvas. There are no dropped assignments. If you have extenuating circumstances you must speak to me before each unit midterm and can receive extensions beyond the 3-days for no penalty. Otherwise, the late penalty is 50% if you don't request an extension within the 3 days of assignment submission. See Quizwork 1 for more information on these policies.
Exams:	There are three midterm exams throughout the semester. Exams 1 and 2 will have a second-try option ***with completely new questions*** and if you elect to take the exam a second time, your grade will be ***averaged***. You should elect to take the second try only if you have the time to study and improve your grade. Exam 3 has no retake option. You should, under no circumstances, blow off the first exam because you know there will be a second-try option. These exam scores ***average***. No exam scores will be dropped, if you get a worse grade the second try, your average grade will be lower than the first exam. The second-try exams are not taken during class. Second-try averaging exams only offered outside of class in the evenings in-person or scheduled through DRES. Signup for these exams will be available on Canvas.

Grading:	Component	(Percentage)	Date:
	Quizworks	(35%)	Weekly on Mondays, 12 total
	Exam 1	(15%)	Monday Feb 19, averaging: Wed Feb 28
	Exam 2	(15%)	Monday April 1, averaging: Wed Apr 10
	Exam 3	(15%)	Monday, April 22
	Final Exam	(20%)	Friday May 3rd, 8:00 AM – 11:00 AM

GPA Grade Scale: A+ = 4.0; A = 4.0; A- = 3.67; B+ = 3.33; B = 3.0; B- = 2.67; C+ = 2.33; C = 2.0; C- = 1.67; D+ = 1.33; D = 1.0; D- = 0.67; F = 0.0.

Grading from Canvas Breakdown:

97.00 – 100.00	A+
93.00 – 96.99	A
90.00 – 92.99	A-
87.00 – 89.99	B+
83.00 – 86.99	B
80.00 – 82.99	B-
77.00 – 79.99	C+
73.00 – 76.99	C
70.00 - 72.99	C-
67.00 – 69.99	D+
63.00 – 66.99	D
60.00 - 62.99	D-
below 60	F

Extra Credit: There is an extra credit option that will add one percentage point to your final grade out of 100%. It is to check a book out of Grainger Engineering Library or read a book in-library that is on Course Reserves, submit the proof of checkout that you get from the library as an email via a google form, along with answers to questions about the physical book you read from the library and making an AIAA citation for your book following conventions.

Integrity

You are not to use AI to generate your assignments. If you want to do all of your own work with the course notes, office hours, and collaboration with peers, solve and finalize the problems, and then use AI to compare results, that would be okay with me. If you want to spend your time outside of class learning how to use AI commercial tools, you are welcome to do so. The aerospace industry is a regulated industry. The expectation I have is that by being in AE 312 you want to learn how to solve problems and be responsible engineers who understand physical science and the limitations of various approximate methods. If you cannot develop the skills to solve problems on your own, you are not developing the required skill to validate AI solutions. More importantly, you are not learning how to implement tools in a way that prioritizes safety of a final engineering product that could harm passengers, maintenance workers, manufacturing workers, operators, pilots, bystanders, or the environment. You need to all learn, as individuals, the content of the course. If you want to learn how to develop AI or Machine Learning tools to solve unique and complicated engineering problems, consider taking CS 440 or CS 441 or similar courses.

Collaboration with classmates on assignments is encouraged: you can assist and direct, check numerical values for solutions with other students, and explain components of the process, but you ***should not volunteer to do the work for anybody besides yourself***. I will offer extensions to anyone who is struggling to keep up with work due to emergencies or complicated circumstances. If you do the work for someone

else or copy work from someone else, it is an infringement of academic integrity policy, and I am mandated to report such infringements through the FAIR system. I expect you to try to do your own work and accept the grading penalties for work that is incorrect, incomplete, or poorly done. Academic dishonesty may result in a failing grade. Every student is expected to review and abide by the Academic Integrity Policy: https://studentcode.illinois.edu/article1/part4/1-401/. Ignorance is not an excuse for any academic dishonesty.

The instructor reserves the right to make any changes they consider academically advisable. Such changes, if any, will be announced in class.

Additional Resources:

1. *Introduction to Compressible Fluid Flow*, Patrick H. Oosthuizen and William E. Carscallen
2. *Introductory Gas Dynamics*, A. J. Chapman and W. F. Walker.
3. *Gas Dynamics*, R. D. Zucker.
4. *Gas Dynamics*, Volume I, M. J. Zucrow and J. D. Hoffman.
5. *The Dynamics and Thermodynamics of Compressible Fluid Flow*, Volume I, A. H. Shapiro.
6. *Elements of Gasdynamics*, H. W. Liepmann and A. Roshko.
7. *Compressible Fluid Dynamics*, P. H. Thompson.
8. *Fundamentals of Gas Dynamics*, R. P. Benedict.
9. *Modern Compressible Flow*, J. D. Anderson.
10. *Gasdynamics: Theory and Applications*, G. Emanuel.
11. *Compressible Fluid Flow*, M. A. Saad.
12. Compressible Fluid Dynamics, B. K. Hodge and K. Koenig.
13. *Applied Gas Dynamics*, E. Rathakrishnan.
14. *Gas Dynamics*, J. E. A. John.

Campus Information & Mandated Reporting Notice

Disability Resources and Educational Services

To obtain disability-related academic adjustments and/or auxiliary aids, students with disabilities must contact the course instructor and the Disability Resources and Educational Services (DRES) as soon as possible. To contact DRES, you may visit 1207 S. Oak St., Champaign, call 333-4603, e-mail disability@illinois.edu or go to the DRES website. If you are concerned you have a disability-related condition that is impacting your academic progress, there are academic screening appointments available on campus that can help diagnosis a previously undiagnosed disability by visiting the DRES website and selecting "Sign-Up for an Academic Screening" at the bottom of the page.

Writer's Workshop

If you are interested in obtaining information to improve writing, study skills, time management or organization, the following campus resources are available to all students: Writers Workshop (illinois.edu)

Academic Assistance Links

Office of the Dean of Students at the University of Illinois (uiuc.edu)
Office of Minority Student Affairs at the University of Illinois
Home | International Student & Scholar Services (illinois.edu)
Center for Academic Resources in Engineering (CARE)

Health

Significant stress, mood changes, excessive worry, substance/alcohol misuse or interferences in eating or sleep can have an impact on academic performance, social development, and emotional wellbeing. The University of Illinois offers a variety of confidential services including individual and group counseling,

crisis intervention, psychiatric services, and specialized screenings which are covered through the Student Health Fee. If you or someone you know experiences any of the above mental health concerns, it is strongly encouraged to contact or visit any of the University's resources provided below. Getting help is a smart and courageous thing to do for yourself and for those who care about you.

- Counseling Center (217) 333-3704
- McKinley Health Center (217) 333-2700
- National Suicide Prevention Lifeline (800) 273-8255
- Rosecrance Crisis Line (217) 359-4141 (available 24/7, 365 days a year)

If you are in immediate danger, call 911.

Sexual Misconduct Policy and Reporting

The University of Illinois is committed to combating sexual misconduct. As such, you should know that faculty and staff members are required to report any instances of sexual misconduct—which can include harassment, sexual assault, sexual exploitation, dating violence, domestic violence, and stalking—to the University's Title IX & Disability Office. What this means is that as your instructor, I am required to report any incidents of sexual misconduct that are directly reported to me, or of which I am somehow made aware. When a report is received, an individual with the Title IX & Disability Office reaches out to provide information about rights and options, including accommodations, support services, the campus disciplinary process, and law enforcement options.

There is an exception to this reporting requirement about which you should be aware. A list of the designated University employees who, as counselors, confidential advisors, and medical professionals, do not have this reporting responsibility and can maintain confidentiality, can be found here: Resources for Students, At Illinois We Care.

University of Illinois Nondiscrimination Statement

The commitment of the University of Illinois at Urbana-Champaign (Illinois) to the most fundamental principles of academic freedom, equality of opportunity, and human dignity requires that decisions involving students and employees be based on merit and be free from invidious discrimination in all its forms. This policy is designed to promote a safe and healthy learning and work environment and to comply with multiple laws that prohibit discrimination, including: Equal Pay Act of 1963, Title VI and VII of the Civil Rights Act of 1964, the Americans with Disabilities Act Amendments Act, the Rehabilitation Act of 1973, the Age Discrimination in Employment Act of 1967, the Age Discrimination Act of 1975, Title IX of the Education Amendments Act of 1972, the Pregnancy Discrimination Act of 1978, the Uniformed Services Employment and Re-employment Act, the Vietnam-Era Veterans Readjustment Assistance Act of 1974, the Genetic Information Nondiscrimination Act of 2008, and the Illinois Human Rights Act. This policy and the associated procedures are established to provide a means to address complaints of discrimination or harassment based on the protected categories described herein.

It is the policy of the University not to engage in discrimination or harassment against any person because of race, color, religion, sex, pregnancy, disability, national origin, citizenship status, ancestry, age, order of protection status, genetic information, marital status, sexual orientation, gender identity, arrest record status, unfavorable discharge from the military, or status as a protected veteran and to comply with all federal and state nondiscrimination, equal opportunity, and affirmative action laws, orders, and regulations.

Land Acknowledgement Statement suggested by Native American House

"I/We would like to begin today by recognizing and acknowledging that we are on the lands of the Peoria, Kaskaskia, Piankashaw, Wea, Miami, Mascoutin, Odawa, Sauk, Mesquaki, Kickapoo, Potawatomi, Ojibwe, and Chickasaw Nations. These lands were the traditional territory of these Native Nations prior to their forced removal; these lands continue to carry the stories of these Nations and their struggles for survival and identity.

As a land-grant institution, the University of Illinois has a particular responsibility to acknowledge the peoples of these lands, as well as the histories of dispossession that have allowed for the growth of this institution for the past 150 years. We are also obligated to reflect on and actively address these histories and the role that this university has played in shaping them. This acknowledgement and the centering of Native peoples is a start as we move forward for the next 150 years."

How to respond to an emergency
Emergencies can happen anywhere and at any time. It is important that we take a minute to prepare for a situation in which our safety or even our lives could depend on our ability to react quickly. When we're faced with any kind of emergency – like fire, severe weather or if someone is trying to hurt you – we have three options: **run**, **hide** or **fight**.

Run
Leaving the area quickly is the best option if it is safe to do so.

- Take time now to learn the different ways to leave your building.
- Leave personal items behind.
- Assist those who need help but consider whether doing so puts yourself at risk.
- Alert authorities of the emergency when it is safe to do so.

Hide
When you can't or don't want to run, take shelter indoors.

- Take time now to learn the different ways to seek shelter in your building.
- If severe weather is imminent, proceed to the nearest indoor storm refuge area.
- If someone is trying to hurt you and you can't evacuate, get to a place where you can't be seen, lock or barricade your area, silence your phone, don't make any noise and don't come out until you receive an Illini-Alert indicating it is safe to do so.

Fight
You may need to fight to increase your chances of survival.

- Think about what kind of common items are in your area which you can use to defend yourself.
- Team up with others to fight if the situation allows.
- Mentally prepare yourself – you may be in a fight for your life.

Please be aware of persons with disabilities who may need additional assistance in emergency situations.

Other resources:
https://police.illinois.edu/safe for more information on how to prepare for emergencies, including how to run, hide or fight and building floor plans that can show you safe areas.

http://emergency.illinois.edu/ to sign up for Illini-Alert text messages.

Follow the University of Illinois Police Department on Twitter and Facebook to get regular updates about campus safety.

Learn more about your building
Taking a minute to review exits, storm refuge areas, areas of rescue assistance and evacuation assembly areas in building that you use often could save your life in an emergency.
For Campus Instructional Facility: u1545.pdf (illinois.edu)
View all building floor plans.