

Introduction to Compressible Flow

EML 5714

M W F, Period 2, 8:30 AM - 9:20 AM,

NEB 0201

Academic Term: Fall 2024

“Big whorls have little whorls
which feed on their velocity
and little whorls have lesser whorls
and so on to viscosity”

~Lewis Fry Richardson, 1922

(play on Augustus de Morgan's famous paraphrasing of Jonathan Swift)

Professor

Associate Professor S. A. E. Miller, Ph.D.

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Contact preference - <https://ufl.instructure.com> message via Canvas

Teaching Assistant/Peer Mentor/Supervised Teaching Student:

Ms. Mary 'Ginny' Rowe, contact via canvas

Course Description

Course catalogue, “One-dimensional and quasi-one-dimensional compressible fluid flows. Includes Mach waves, normal shocks, oblique shocks, Prandtl-Meyer expansions, isentropic flow with area change, Fanno flow, and Rayleigh flow.” (Credits 3)

Course Pre-Requisites / Co-Requisites

EAS 4101 (Aerodynamics) and/or EGN 3353C (Fluid Mechanics), or consent of professor.

Course Objectives

This course will introduce students to the theory, physics, and analytical solutions of compressible fluid flow phenomena. We will examine the physics of shock waves, expansion waves, Mach waves, isentropic flow through nozzles and inlets, briefly examine Fanno/Rayleigh flow, wind tunnels, transonics, hypersonics, supersonics, and additional select topics. Illustrations and photographs of the phenomena will be presented. Application of the material will be given in the context of the professor's research, contemporary developments, and historical perspective. The material will be presented through lectures, assigned reading, and the class website. At the end of the course the students will possess the foundational knowledge of compressible flow.

Materials and Supply Fees

None.

Required Textbooks and Software

Various handout material provided digitally by professor. No software is required. A scientific calculator is highly recommended.

- Liepmann, H. W. and Roshko, A., 'Elements of Gas Dynamics,' Dover, 2001.
- John, J. E. and Keith, T. G., 'Gas Dynamics,' Pearson Prentice Hall, Ed. 3, ISBN: 9780131206687, 2006.
- Anderson, J., 'Modern Compressible Flow: With Historical Perspective,' McGraw-Hill, Ed. 3, ISBN: 978-0072424430, 2003.
- Oosthuizen, P. H. and Carscallen, W. E., 'Introduction to Compressible Flow,' CRC Press, Ed. 2, ISBN: 9781439877913, 2013.
- Various handout material provided by professor.

Recommended Materials

- See above.

Required Computer

UF student computing requirement: <https://news.it.ufl.edu/education/student-computing-requirements-for-uf/>

Course Schedule

The first two weeks will focus on introduction material, the third and fourth weeks will focus on isentropic flows, the fifth through ninth week will focus on normal shock waves and oblique shock waves, the tenth through eleventh week will focus on expansions, two weeks following will focus on compressible streamtubes, and the final weeks will focus on special topics.

Important Dates

See all important dates on canvas assignments and in class announcements.

Attendance Policy, Class Expectations, and Make-Up Policy

Required statement by the University of Florida: Excused absences must be consistent with university policies in the Graduate Catalog (<https://catalog.ufl.edu/graduate/regulations>) and require appropriate documentation. Additional information can be found here: <https://catalog.ufl.edu/UGRD/academic-regulations/attendance-policies/>

Policy on Deadlines

- Late submission of class material is not accepted (late homework is assessed a 10% penalty, and each day after an additional 25% penalty).
- Do not email or contact the professor with explanations for missed deadlines, late work, etc. Students are responsible for turning in assignments on time.
- If a tragedy has occurred, then instructor notifications are required. See <https://care.dso.ufl.edu/instructor-notifications> for details. Note that, "Professors have the right to accept or reject the notification."

Policy on Ethics

- Any kind of cheating, lying, dishonesty, or any other honor code violation results in a failing grade for the entire course. Violations reported without student notification per university policy.
- All submissions must be your own original work. Do not use solution manuals or any other help (examples - forums, websites, groupme, other help, etc.) for anything. Searching for solutions online is considered not your own analyses. Violations reported without student notification per university policy.

Graduate / Undergraduate Co-listing

Graduate and undergraduate sections of this course may occur concurrently. Students in the graduate section will be required to complete a term paper.

Evaluation of Grades and Grading Policy

Course Grade Evaluation Criteria

- Graded material will be weighted as 0.10 for homework, 0.10 for term paper, 0.40 for exam 1, and 0.40 for exam 2.
- The term paper assignment must be completed or a failing grade may be assigned for the course.
- Homework
 - All homework assignments must be completed (even if late) or a failing may be assigned for the course.
 - The lowest homework grade will be dropped and will not be accounted for in your grade.
- The final grade will be assigned via the straight scale:
 - 4.00 (A) → [93.33, 100.00],
 - 3.67 (A-) → [90.00 to 93.33),
 - 3.33 (B+) → [86.67 to 90.00),
 - 3.00 (B) → [83.33 to 86.67),

- 2.67 (B-) → [80.00 to 83.33),
- 2.33 (C+) → [76.67 to 80.00),
- 2.00 (C) → [73.33 to 76.67),
- 1.67 (C-) → [70.00 to 73.33),
- 1.33 (D+) → [66.67 to 70.00),
- 1.00 (D) → [63.33 to 66.67),
- 0.67 (D-) → [60.00 to 63.33), and
- 0.00 (E) → [00.00 to 60.00).
- Final grades are rounded to the nearest hundredths place before assignment.
- At the discretion of the professor, the final course grades may be curved.
- Students who are active throughout the course, interact regularly, continually ask excellent questions, turn their work in on time, may receive significant letter grade increases at the end of the course, at the discretion of the professor.

Homework

- The purpose of homework is to learn and understand the material. Students are responsible for understanding the homework problems and solutions.
- Students who turn in fully completed homework will receive 100% credit. All original work must be shown. Answers must be boxed with units. Partial solutions of the homework will be posted on the class website after the due date. Students will submit solutions of the homework problems via the course website. Only PDF files are accepted.

Term Paper

Students in the graduate section are expected to write a term paper. The details of the assignment, format, and deadline(s) are posted on the class website. *The paper must be of AIAA Journal submission quality.*

Grade Corrections

Corrections of grades must be submitted promptly within 3 business days after grade posting. A statement in writing on why there has been an error must be submitted through Canvas. The message should be directed towards the TA / Graders for homework and to the professor for other assignments.

More information on UF grading policy may be found at:

<https://catalog.ufl.edu/ugrad/current/regulations/info/grades.aspx>

Students Requiring Accommodations

Students with disabilities who experience learning barriers and would like to request academic accommodations should connect with the disability Resource Center by visiting <https://disability.ufl.edu/students/get-started/>. It is important for students to share their accommodation letter with their instructor and discuss their access needs, as early as possible in the semester.

Course Evaluation

Students are expected to provide professional and respectful feedback on the quality of instruction in this course by completing course evaluations online via GatorEvals. Guidance on how to give feedback in a professional and respectful manner is available at <https://gatorevals.aa.ufl.edu/students/>. Students will be notified when the evaluation period opens, and can complete evaluations through the email they receive from GatorEvals, in their Canvas course menu under GatorEvals, or via <https://ufl.bluera.com/ufl/>. Summaries of course evaluation results are available to students at <https://gatorevals.aa.ufl.edu/public-results/>.

In-Class Recording

Students are allowed to record video or audio of class lectures. However, the purposes for which these recordings may be used are strictly controlled. The only allowable purposes are (1) for personal educational use, (2) in connection with a complaint to the university, or (3) as evidence in, or in preparation for, a criminal or civil proceeding. All other purposes are prohibited. Specifically, students may not publish recorded lectures without the written consent of the instructor.

A “class lecture” is an educational presentation intended to inform or teach enrolled students about a particular subject, including any instructor-led discussions that form part of the presentation, and delivered by any instructor hired or appointed by the University, or by a guest instructor, as part of a University of Florida course. A class lecture does not include lab sessions, student presentations, clinical presentations such as patient history, academic exercises involving solely student participation, assessments (quizzes, tests, exams), field trips, private conversations between students in the class or between a student and the faculty or lecturer during a class session.

Publication without permission of the instructor is prohibited. To “publish” means to share, transmit, circulate, distribute, or provide access to a recording, regardless of format or medium, to another person (or persons), including but not limited to another student within the same class section. Additionally, a recording, or transcript of a recording, is considered published if it is posted on or uploaded to, in whole or in part, any media platform, including but not limited to social media, book, magazine, newspaper, leaflet, or third party note/tutoring services. A student who publishes a recording without written consent may be subject to a civil cause of action instituted by a person injured by the publication and/or discipline under UF Regulation 4.040 Student Honor Code and Student Conduct Code.

University Honesty Policy

UF students are bound by The Honor Pledge which states, “We, the members of the University of Florida community, pledge to hold ourselves and our peers to the highest standards of honor and integrity by abiding by the Honor Code. On all work submitted for credit by students at the University of Florida, the following pledge is either required or implied: “On my honor, I have neither given nor received unauthorized aid in doing this assignment.” The Honor Code (<https://sccr.dso.ufl.edu/process/student-conduct-code/>) specifies a number of behaviors that are in violation of this code and the possible sanctions. Furthermore, you are obligated to report any condition that facilitates academic misconduct to appropriate personnel. If you have any questions or concerns, please consult with the instructor or TAs in this class.

Commitment to a Safe and Inclusive Learning Environment

The Herbert Wertheim College of Engineering values varied perspectives and lived experiences within our community and is committed to supporting the University’s core values, including the elimination of discrimination. It is expected that every person in this class will treat one another with dignity and respect regardless of race, creed, color, religion, age, disability, sex, sexual orientation, gender identity and expression, marital status, national origin, political opinions or affiliations, genetic information, and veteran status.

If you feel like your performance in class is being impacted by discrimination or harassment of any kind, please contact your instructor or any of the following:

- Your academic advisor or Graduate Coordinator
- HWCHE Human Resources, 352-392-0904, student-support-hr@eng.ufl.edu
- Pam Dickrell, Associate Dean of Student Affairs, 352-392-2177, pld@ufl.edu
- Toshikazu Nishida, Associate Dean of Academic Affairs, 352-392-0943, nishida@eng.ufl.edu

Software Use

All faculty, staff, and students of the University are required and expected to obey the laws and legal agreements governing software use. Failure to do so can lead to monetary damages and/or criminal penalties for the individual violator. Because such violations are also against University policies and rules, disciplinary action will be taken as appropriate. We, the members of the University of Florida community, pledge to uphold ourselves and our peers to the highest standards of honesty and integrity.

Student Privacy

There are federal laws protecting your privacy with regards to grades earned in courses and on individual assignments. For more information, please see: <https://registrar.ufl.edu/ferpa.html>

Campus Resources:

Health and Wellness

U Matter, We Care:

Your well-being is important to the University of Florida. The U Matter, We Care initiative is committed to creating a culture of care on our campus by encouraging members of our community to look out for one another and to reach out for help if a member of our community is in need. If you or a friend is in distress, please contact umatter@ufl.edu so that the U Matter, We Care Team can reach out to the student in distress. A nighttime and weekend crisis counselor is available by phone at 352-392-1575. The U Matter, We Care Team can help connect students to the many other helping resources available including, but not limited to, Victim Advocates, Housing staff, and the Counseling and Wellness Center. Please remember that asking for help is a sign of strength. In case of emergency, call 9-1-1.

Counseling and Wellness Center: <https://counseling.ufl.edu>, and 392-1575; and the University Police Department: 392-1111 or 9-1-1 for emergencies.

Sexual Discrimination, Harassment, Assault, or Violence

If you or a friend has been subjected to sexual discrimination, sexual harassment, sexual assault, or violence contact the **Office of Title IX Compliance**, located at Yon Hall Room 427, 1908 Stadium Road, (352) 273-1094, title-ix@ufl.edu

Sexual Assault Recovery Services (SARS)

Student Health Care Center, 392-1161.

University Police Department at 392-1111 (or 9-1-1 for emergencies), or <http://www.police.ufl.edu/>.

Academic Resources

E-learning technical support, 352-392-4357 (select option 2) or e-mail to Learning-support@ufl.edu.
<https://elearning.ufl.edu/>.

Career Connections Center, Reitz Union, 392-1601. Career assistance and counseling; <https://career.ufl.edu>.

Library Support, <http://cms.uflib.ufl.edu/ask>. Various ways to receive assistance with respect to using the libraries or finding resources.

Teaching Center, Broward Hall, 392-2010 or 392-6420. General study skills and tutoring.
<https://teachingcenter.ufl.edu/>.

Writing Studio, 302 Tigert Hall, 846-1138. Help brainstorming, formatting, and writing papers.
<https://writing.ufl.edu/writing-studio/>.

Student Complaints Campus: <https://sccr.dso.ufl.edu/policies/student-honor-code-student-conduct-code/>; <https://care.dso.ufl.edu>.

On-Line Students Complaints: <https://distance.ufl.edu/getting-help/>; <https://distance.ufl.edu/state-authorization-status/#student-complaint>.