

# AERO 4331 Aerodynamics II

## Course Syllabus

### Spring 2025

#### COURSE MOTIVATION

This course builds on the students' background in Fluid Mechanics and Thermodynamics to deal primarily with flows (low-speed and high-speed) relevant to aerospace applications.

**PREREQUISITE** AERO 3312 Aerodynamics I

#### SCHEDULED MEETING TIMES

Section CRN	Time	Location
24772	T R 01:30 pm - 02:50 pm	Liberal Arts Building 318

**INSTRUCTOR:** Dr. Md Mahamudur Rahman

**E-MAIL:** [mrahman15@utep.edu](mailto:mrahman15@utep.edu)

**OFFICE HOURS:** By Appointment (via e-mail)

**OFFICE:** Engr. Bldg. A#118

**TEXTBOOK:** Fundamentals of Aerodynamics, 5<sup>th</sup>, or 6<sup>th</sup>, or 7<sup>th</sup> Edition by John Anderson

**BLACKBOARD:** Instructor will be using Blackboard for uploading lecture videos, updating the syllabus (if necessary), and communicating with students via "Announcements" and email.

#### COURSE OBJECTIVES:

The objectives of this course are to examine the fundamentals of flowing fluids that can be treated as compressible and viscous, and to use this foundation to analyze and predict the dynamics of fluid flow fields in applied engineering and science. To this end, we will come to understand what it means to be compressible and viscous fluid, analyze and develop subsonic, supersonic and hypersonic flow field expressions, and make use of computational fluid dynamics (CFD) simulation on supersonic and hypersonic vehicles.

#### TOPICS

- Preliminary aspects of compressible flow
- Normal shock waves
- Oblique shock and expansion waves
- Compressible flow through nozzles, diffusers, and wind tunnels
- Subsonic compressible flow over airfoils
- Linearized supersonic flow
- Numerical techniques for nonlinear supersonic flow
- Hypersonic flow
- Fundamental principles of viscous flow
- Exact solution of Navier-Stokes equation
- Laminar and turbulent boundary layers
- Computational fluid dynamics (CFD) simulation of supersonic and hypersonic flows

## COURSE SCHEDULE

Week	Week of	Reading	Lecture Topic	Due
1	01/20	7.1 – 7.2	<b>Part#1: Inviscid Compressible Flows</b> <b>Chapter 7: Preliminary Aspects</b> 1. Review of thermodynamics	
2	01/27	7.2 – 7.3 2.3	2. Review of thermodynamics 3. Definition of compressibility 4. Reynolds transport theorem	<b>Quiz#1</b>
3	02/03	2.4 – 2.5	5. Conservation of mass 6. Conservation of linear momentum	<b>HW-1</b>
4	02/10	2.7	7. <b>Brief tutorial on NX CAD drawing</b> 8. Conservation of energy	<b>HW-2</b>
5	02/17	7.4 – 7.5 8.1 – 8.2	9. Inviscid compressible flow governing equations. 10. Total (stagnation) conditions <b>Chapter 8: Normal Shock Waves</b> 11. Normal shock equations	<b>Quiz#2</b> <b>HW-3</b>
6	02/24	8.3, 8.6	12. Special forms of energy equation 13. Normal shock-wave properties 14. <b>Exam#1 (Ch. 7 – 8)</b>	<b>Exam#1</b>
7	03/03	8.6, 8.5 9.1 – 9.2	15. Normal shock-wave properties 16. When is a flow compressible? <b>Chapter 9: Oblique Shock and Expansion Waves</b> 17. Introduction 18. Oblique shock relations	<b>HW-4</b> <b>Quiz#3</b>
8	03/10	<b>No Class (Spring Break)</b>		
9	03/17	9.3 – 9.6	19. Supersonic flow over wedges and cones, Shock interactions and reflections, Detached shock wave in front of a blunt body. Prandtl-Meyer expansion waves	<b>HW-5</b>
10	03/24	11.2 – 11.6	<b>Chapter 11: Subsonic Compressible Flow over Airfoils: Linear Theory</b> 20. The velocity potential equation, The linearized velocity potential equation 21. Prandtl-Glauert compressibility correction, Improved compressibility corrections, Critical Mach number, The supercritical airfoil 22. <b>Project#1 CAD and report due.</b>	<b>Quiz#4</b> <b>Project#1</b>
11	03/31	12.2 – 12.3 13.2, 13.4	<b>Chapter 12: Linearized Supersonic Flow</b> 23. Linearized supersonic pressure coefficient, supersonic airfoils. <b>Chapter 13: Numerical Techniques for Nonlinear Supersonic Flow</b> 24. Method of characteristics, Finite-difference methods 25. <b>Brief tutorial on NX StarCCM+ (Supersonic / Hypersonic)</b> 26. <b>Exam#2 (Ch. 9, 11, 12)</b>	<b>Exam#2</b>

12	04/07	14.1 – 14.2	<b>Chapter 14: Hypersonic Flow</b> 27. Qualitative aspects of hypersonic flow, Newtonian theory <b>Chapter 10: Compressible Flow Through Nozzles, Diffusers, and Wind Tunnels</b> 28. Governing equations for quasi-1-D flow 29. Nozzle flows, Diffusers	<b>Quiz#5</b> <b>HW-6</b>
13	04/14	14.3 15.2 – 15.5 16.3	30. Supersonic wind tunnel <b>Part#2: Viscous Flows</b> <b>Chapter 15: Introduction to the Fundamental Principles and Equations of Viscous Flow</b> 31. Qualitative aspects of viscous flow 32. Viscosity and thermal conduction, The Navier-Stokes equations, Viscous flow energy equation <b>Chapter 16: Couette Flow</b> 33. Constant property Couette flow	<b>HW-7</b>
14	04/21	17.2 – 17.3	<b>Chapter 17: Boundary Layers</b> 34. Boundary-layer properties, The boundary-layer equations	<b>HW-8</b> <b>Quiz#6</b>
15	04/28	18.5 19.1 – 19.2	<b>Chapter 18: Laminar Boundary Layers</b> 35. Stagnation point aerodynamic heating <b>Chapter 19: Turbulent Boundary Layers</b> 36. Turbulent boundary layers on a flat plate 37. <b>Exam#3 (Ch. 14 – 19)</b>	<b>Exam#3</b>
16	05/05	19.1 – 19.2	38. <b>Project#2 report due.</b> 39. <b>3-D printed prototype due (Project#1 and #2)</b> 40. <b>Project presentations (Project#1 and #2)</b>	<b>HW-9</b> <b>Project#2</b>

**GRADING:** Your grade for the course will be determined using the following formula:

Exams	10%	×3	30%
Class Project	20%	×2	40%
Quizzes	10%		10%
Homework	10%		10%
Class Participation	10%		10%

***A (100-90): B (89-80): C (79-70): D (69-60): F (59 and Below)***

The instructor reserves the right to revise this grading plan.

**ABET PROGRAM OUTCOMES:** This class addresses the following ABET objectives:

Outcomes 1 - 7	Evidence
1. An ability to identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics	Homework, Exams, Quizzes, Projects
2. An ability to apply engineering design to produce solutions that meet specified needs with consideration of public health, safety, and welfare, as well as global, cultural, social, environmental, and economic factors	Homework, Exams, Quizzes, Projects, Classroom discussions
3. An ability to communicate effectively with a range of audiences	Design project report and in-class participation
4. An ability to recognize ethical and professional responsibilities in engineering solutions and make informed judgements, which must consider the impact of engineering solutions in global, economic, environmental and societal contexts	Classroom discussion of sustainability. Design project
5. An ability to function effectively on a team whose members together provide leadership, create a collaborative and inclusive environment, establish goals, plan tasks, and meet objectives	Design project
6. An ability to develop and conduct appropriate experimentation, analyze and interpret data, and use engineering judgement to draw conclusions	Design project; classroom example and homework problems
7. An ability to acquire and apply new knowledge as needed, using appropriate learning strategies	Homework; Final report for the design project

**Exams:** There are three exams. Makeup exams are **NOT** given.

**Projects:** One project will be assigned during the semester. The project will consist of small design type problem that will have one CAD development and analytical solution part (project#1), and one numerical solution (project#2) part.

**Assignments and Quizzes:** Homework and quizzes will include either concept questions, problems, or both. **NO** extensions on quizzes. The quizzes will be mostly sudden in-class. The homework assignments and quizzes are posted to blackboard.

**Late submission policy on homework:** There will be a penalty of 5% for each day late.

**Communication via email/Teams:** When sending an email/message you must include class name, section number and class time.

**Drop/Withdrawal Deadline:** The student is responsible for dropping the course (if required) before the deadline. The instructor cannot drop the student from the course after this deadline.

#### **ACES & Tutoring Center**

Please note there are tutoring services available in the ACES center. Check the schedule of the tutors and make use of the services.

## **Academic Dishonesty**

Strictly prohibited the use of studying support websites, solution manuals, etc. during the exam. It is easy to detect the students who use these online tools or solutions. Your case will be sent to the Office of Community Standards (OCS).

During exams and quizzes, you are not allowed to use any form of Wi-Fi enabled electronic device, including cell phones or other electronic communication devices or methods (wrist watches, earbuds, etc.). No wristwatch or other electronic device may be worn.

As a part of the zero-tolerance policy, if you have a cellphone or other electronic device capable of communication on your person; or if any proctor sees or hears any electronic device during the exam or if you share your work with someone else, you will be reported to the proper authorities, and you may receive a zero on the exam and an F in the class. Other actions including suspension may also be pursued.

If you have a disability that requires the use of an electronic device during the exam you must have a letter of accommodation from the Center for Accommodations and Support Services (CASS). This accommodation must be arranged in advance with the instructor.

No electronic version of the book, loose paper printouts of the book or extra sheets of paper of any kind are allowed unless explicitly mentioned in writing by the instructor.

You must show your work to all problems. You must use the paper provided by the instructor. If no work is shown, you may not receive credit. After the exam, the instructor may require you to explain how you solved a problem on the exam. If you refuse to or cannot explain your work, you may be subject to disciplinary action.

During exams, you will not be allowed to leave the examination room until you complete the exam. This includes restroom breaks. Students with disabilities must have a letter of accommodation and coordinate this in advance with the instructor.

University approved recording devices may be located at various locations in the room and may be out of sight of the students. These recordings will be managed according to the UTEP approved regulations for such media. The instructor may create a record of your activity during the exam and may take photographs of your work during the exam.

If you are suspected of scholastic dishonesty, you may not be directly confronted about your conduct by the instructor or proctor. You will, however, be reported to the Office of Community Standards (OCS) and your exam will not be admissible. Your grade in the class may not be available until OCS makes a final ruling, this may adversely impact your ability to enroll in other classes.

If you arrive more than 15 minutes late for an exam, you will not be allowed to enter the examination room.

If you miss more than one exam, the instructor may choose to administratively drop you from the class. This may adversely impact on visas and financial aid.

No food or drinks will be allowed in the examination room.

Departmental policy allows for the use of assigned seats. All students must present their UTEP issued ID prior to and during every exam and may be required to sign in. Not having a UTEP issued ID when asked will result in forfeiture of the exam.

Scholastic dishonesty on homework, lab assignments and all other class assignments will be held to the same standards and requirements of academic honesty as quizzes and exams.

Use of Artificial Intelligence (AI) technologies or automated tools, particularly generative AI such as [ChatGPT](#) or [DALL-E](#), is **not allowed** for assignments in this class. Each student is expected to use critical and creative thinking skills to complete tasks and not rely on computer-generated ideas. Any direct use of AI-generated materials submitted as your own work will be treated as plagiarism and reported to the Office of Community Standards (OCS).

### **Class Attendance Policy**

Attendance is mandatory. Anyone with 5 or more absences will be dropped from the class at the instructor's discretion. A drop for not attending will count toward the State Allowed Six Drop Limit. If you are failing the class at the time of the drop, you may also be given a WF designation. Be advised that a drop could adversely impact visa status, financial aid, and other programs.

As per UTEP rules, you may be asked to show a UTEP ID at any time during class. Anyone who is present and not registered in the class will be subject to disciplinary action unless the instructor gives prior approval.

### **Excused Absence for Exams**

The UTEP catalog allows Exam Absence to be excused ONLY for University-Recognized Activities and very specific other situations. Medical absence is NOT allowed in the UTEP catalog. For consistency with the catalog, students will NOT be excused from exams due to illness.

There will be no makeup exams administered. If you have a university approved excuse, your instructor will have a process for determining how to handle the missing grade outlined in the syllabus. However, no makeup exams will be given.

### **COVID-19 Precautions**

Please stay home if you have been diagnosed with COVID-19 or are experiencing COVID-19 symptoms. If you are feeling unwell, please let me know as soon as possible, so that we can work on appropriate accommodation. If you have tested positive for COVID-19, you are encouraged to report your results to [covidaction@utep.edu](mailto:covidaction@utep.edu) , so that the Dean of Students Office can provide you with support and help with communication with your professors.

The Center for Disease Control and Prevention recommends that people in areas of substantial or high COVID-19 transmission wear face masks when indoors in groups of people.

### **Harassment Policy**

The department has a zero-tolerance policy for harassment. Engagement in any behavior considered harassment will be reported to the proper authorities. In addition to generally understood forms of harassment, the department also treats the following behavior as harassment:

- Repeated emails and/or calls regarding subjects that have already been addressed. Once a decision has been made or a question answered, a student who continues to ask the same question will be given a warning by the recipient of the email/call. If the student continues, the behavior will be reported. Questions that seek understanding of course material are not harassment; but repeated questions about a grade or an administrative decision are.
- Grades are NOT negotiable, ever. If you believe a grading mistake has been made, you must follow the process described in the UTEP catalog. Any request for a grade elevation that is NOT based on a mistake is considered harassment and will be reported immediately.
- Remaining in an office after the occupant requests you leave is considered harassment and potentially threatening. You will be reported immediately without warning and depending on the severity, may be reported to law enforcement.
- Similar behavior towards department staff and student advisors will also be treated as harassment, including persistent phone calls, emails, and badgering. Department staff and student advisors are there to help students and should be treated with due respect.

**Reasonable Accommodation Policy:** If you have a disability and need classroom accommodations, please contact the Center for Accommodations and Support Services (CASS) at 747-5148, or by email to [cass@utep.edu](mailto:cass@utep.edu), or visit their office located in UTEP Union East, Room 106. For additional information, please visit the CASS website at [www.sa.utep.edu/cass](http://www.sa.utep.edu/cass). It is the student's responsibility to request accommodations with CASS and coordinate in advance with the instructor.

**Course Calendar:** May be updated throughout the semester. Always see the current version of the syllabus on Blackboard.

### **Department of Aerospace and Mechanical Engineering Safety Statement**

The Department of Aerospace and Mechanical Engineering at the University of Texas at El Paso is committed to a model of excellence in education that includes providing a safe and healthy environment for its students, staff, faculty, and the general public.

Our goal is to maximize education and research training that can only occur if you, the individual, minimize hazards and risks. This can be done by:

- Providing adequate control of the health and safety risks arising from all activities.
- Consulting with employees on matters affecting their health and safety.
- Providing and maintaining safe laboratories and equipment.
- Ensuring safe handling and use of substance.
- Ensuring all employees are competent to do their task and have adequate training; and
- Maintaining clean, safe, and healthy working conditions

The principal investigator or individual in charge of each laboratory is ultimately responsible for safety in that respective lab. This includes training and ultimate release of the laboratory. Within the Department, we hold every employee (staff, faculty, student) responsible for implementing our safety practices and our departmental safety policy. We hold every employee (staff, faculty, student) responsible for providing leadership within our department to establish effective environmental safety and occupational health standards.

### **Student Success Resource Hub**

UTEP provides a variety of student services and support. Please refer to the QR code below for a listing of campus resources.

- Financial Assistance
- Food and Supply Assistance
- Housing and Utility Assistance
- Physical Health, Mental Health, and Crisis Resources
- Safety and Support Services
- Technology Resources
- Academic and Career Resources
- Additional Resources

