

MECH 5337/6337: Aerodynamics and Control

Class Meeting: 9:00 am - 10:20 pm TR /Psychology Building 115
Instructor: Afroza Shirin, PhD
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Office: A117
Email: ashirin@utep.edu
Office hours: 12:00 PM – 3:00 PM TRs or by appointment.

COURSE DESCRIPTION

- This course provides a comprehensive introduction to aircraft flight dynamics and control principles. Students will build a foundational understanding of aerodynamic forces and moments and learn to extract these for various flight conditions—such as differing angles of attack, Mach numbers, and altitudes—from wind tunnel data. They will explore the equations of motion by incorporating aerodynamic characteristics and thrust and analyzing flight stability and performance. The course also covers methods for linearizing flight dynamics to simplify complex systems, enhancing the understanding of aircraft performance across conditions, and includes designing control systems to support aircraft stability, performance, and flight.
- MATLAB Simulink will be used throughout the course as a tool for implementing and analyzing each topic, offering hands-on experience with modeling flight dynamics and designing control systems to enhance stability and performance. By the end, students will be well-equipped to tackle real-world challenges in aircraft performance and control, gaining valuable insight into modern aerospace engineering applications.
- The students will be evaluated through quizzes, homework, and two projects like take-home exams. The quizzes will cover the fundamental and conceptual aspects, and the homework will cover the mathematical problems and simulations. The take-home exams are designed in a connected way so that students have to implement what they have learned from the beginning to the end. The first take-home exam considers students generating aerodynamic data from wind tunnel data and building aerodynamics and propulsion features in different flight conditions. Then, they incorporate them in equations of motions and solve the dynamics. Students have to use Matlab and Matlab Simuling for the implementations.
- Students will be evaluated through quizzes, homework, and two take-home project exams. Quizzes will assess fundamental and conceptual understanding, while homework will focus on solving mathematical problems and conducting simulations. The take-home exams are designed sequentially, requiring students to apply knowledge gained from start to finish. In the first project exam, students will generate aerodynamic data from wind tunnel data and develop aerodynamic and propulsion characteristics for various flight conditions. They will then incorporate these into the equations of motion and solve the dynamics using MATLAB and MATLAB Simulink for all implementations. For the second take-home exam, students will analyze the stability of the aircraft and design control systems for aircraft stability, performance, and flight. As design constraints, they will ensure flight stability and reduce the % of overshoots and transient and rising time.

COURSE OBJECTIVES

To obtain the fundamentals of aerodynamics and control, the objectives of the course are:

- Students will use mathematical tools and physical laws to obtain aerodynamic characteristics.

- Students will learn mathematical tools to understand dynamics, stability and control.
- Students will use computational tools to validate and analyze the dynamics, stability and controls of aircraft.

TOPICS COVERED

- Basic Understanding of Aerodynamics
- Aircraft Equation of Motions
- Aircraft Performance
- Static and Dynamic Stability
- Control of Aircraft
- Implement and analyze each of the above in the computational domain.

TEXTBOOKS

1. Introduction to Aircraft Flight Mechanics: Performance, Static Stability, Dynamic Stability and Classical Feedback Control, AIAA Education 2nd Edition, by Thomas R. Yechout.
2. Introduction to Flight, 8th edition, by J Anderson.
3. Flight Dynamics, Robert F. Stengel
4. AIRCRAFT DYNAMICS: From Modeling to Simulation, Marcello R. Napolitan.
5. Aircraft Control and Simulation: Dynamics, Controls Design, and Autonomous Systems, 3rd edition, Brian L. Stevens, *Georgia Institute of Technology*; Frank L. Lewis, *University of Texas at Arlington*; Eric N. Johnson, *Georgia Institute of Technology*
6. Flight stability and automatic control Book by Robert C. Nelson

GRADING

- | | |
|--------------------------------------------------|-----|
| • Homework | 25% |
| • Quizzes, attendance, class participation, etc. | 15% |
| • Take Home Exams/Projects I and II | 60% |

Scale A ≥ 90%, B ≥ 80% but <90%, C ≥ 70% but <80%, D ≥ 60% but <70% and F <60%

Take-Home Exams or Projects: There will be two take-home exams. The exam grades will be calculated based on the total test scores. A short paragraph describing how the tool(s) was/were used must be included. A makeup exam will be provided in case of a documented emergency.

Homework: All homework assignments will be through Blackboard.

Lectures: Slides and Reading Material will be uploaded to the Blackboard.

Quizzes: The quizzes will be given in class. No makeup quizzes.

Class Participation and Attendance: An 80% attendance is required.

SOFTWARE

- **Matlab.** <https://www.mathworks.com/academia/tah-portal/university-of-texas-at-el-paso-40735445.html#get>.
- **Matlba toolboxes:** Symbolic, Control Systems, Simscape, Multibody, Aerospace blockset.

TECHNOLOGY REQUIREMENTS

The course content is delivered via the Internet through the Blackboard learning management system. Ensure your UTEP email account is working and you have access to the Web and a stable web browser. Google Chrome and Mozilla Firefox are the best browsers for Blackboard; other browsers may cause complications. When having technical difficulties, update your browser, clear your cache, or try switching to another browser.

You will need to have access to a computer/laptop. You will need to download or update the following software: Microsoft Office, Adobe Acrobat Reader, Windows Media Player, QuickTime, and Java. Check that your computer hardware and software are up-to-date and able to access all parts of the course.

If you do not have word-processing software, you can download Word and other Microsoft Office programs (including Excel, PowerPoint, Outlook, and more) for free via UTEP's Microsoft Office Portal. Click the following link for more information about Microsoft Office 365 and follow the instructions.

IMPORTANT: If you encounter technical difficulties beyond your scope of troubleshooting, please contact the UTEP Help Desk, as they are trained specifically in assisting with technological needs of students. Please do not contact me for this type of assistance. The Help Desk is much better equipped than I am to assist you!

SOFTWARE REQUIREMENTS

- **Matlab:** <https://www.mathworks.com/academia/tah-portal/university-of-texas-at-el-paso-40735445.html#get>.
- **Matlab toolboxes:** Symbolic, Control Systems, Simscape, Multibody, Aerospace blockset. Contact to ETC for specific questions. Engineering building E351D (915) 747-5131.

ATTENDANCE AND PARTICIPATION

Our class meetings are in person at the designated location mentioned above. An 80% of attendance is required. Attendance in the course is determined by participation in the course's learning activities. Your participation in the course is important not only for your learning and success but also to create a community of learners. The completion of the following activities determines participation:

- o Reading/Viewing all course materials to ensure understanding of assignment requirements
- o Participating in class tasks and engaging in discussions with your peers
- o Other activities are indicated in the weekly modules or as indicated by the instructor for daily or weekly class participation.

Because these activities are designed to contribute to your learning each week, they cannot be made up after their due date has passed.

ILLNESS PRECAUTIONS

Please stay home if you have symptoms of a communicable illness. If you are feeling unwell, please let me know as soon as possible so that we can work on appropriate accommodation.

EXCUSED ABSENCES AND/OR COURSE DROP POLICY

According to UTEP Catalog, "At the discretion of the instructor, a student can be dropped from a course because of excessive absences or lack of effort. A grade of "W" will be assigned before the course drop deadline and a grade of "F" after the course drop deadline." See Policies and Regulations in the UTEP Undergraduate Catalog for a list of excuse absences. Therefore, if I find that, due to non-performance in the course, you are at risk of failing, I will drop you from the course. I will provide 24-hour advance notice via email.

OR

I will not drop you from the course. However, if you feel that you are unable to complete the course successfully, please let me know and then contact the Registrar's Office to initiate the drop process. If you do not, you are at risk of receiving an "F" for the course.

MAKEUP WORK

Makeup work will be given only in the case of a documented emergency. Note that makeup work may be in a different format than the original work, may require more intensive preparation, and may be graded with penalty points. If you miss an assignment and the reason is not considered excusable, you will receive a zero. It is therefore important to reach out to me—in advance if at all possible—and explain with proper documentation why you missed a given course requirement. Once a deadline has been established for makeup work, no further extensions or exceptions will be granted.

ALTERNATIVE MEANS OF SUBMITTING WORK IN CASE OF TECHNICAL ISSUES

I strongly suggest that you submit your work with plenty of time to spare in the event that you have a technical issue with the course website, network, and/or your computer. I also suggest you save all your work (answers to discussion points, quizzes, exams, and essays) in a separate Word document as a backup. This way, you will have evidence that you completed the work and will not lose credit. If you are experiencing difficulties submitting your work through the course website, please contact the UTEP Help Desk. You can email me your backup document as a last resort.

INCOMPLETE GRADE POLICY

Incomplete grades may be requested only in exceptional circumstances after you have completed at least half of the course requirements. Talk to me immediately if you believe an incomplete is warranted. If granted, we will establish a contract of work to be completed with deadlines.

ACCOMMODATIONS POLICY

The University is committed to providing reasonable accommodations to students with documented disabilities. Students who become pregnant may also request reasonable accommodation, in accordance with state and federal laws and regulations and University policy. Accommodations that constitute undue hardship are not reasonable. To make a request, please register with the UTEP Center for Accommodations and Support Services (CASS). Contact CASS at 915-747-5148, email them at cass@utep.edu, or apply for accommodations online via the CASS portal.

SCHOLASTIC INTEGRITY

Academic dishonesty is prohibited and is considered a violation of the UTEP Handbook of Operating Procedures. It includes, but is not limited to, cheating, plagiarism, and collusion. Cheating may involve copying from or providing information to another student, possessing unauthorized materials during a test, or falsifying research data on laboratory reports. Plagiarism occurs when someone intentionally or knowingly represents the words or ideas of another as one's own. Collusion involves collaborating with another person to commit any academically dishonest act. Any

act of academic dishonesty attempted by a UTEP student is unacceptable and will not be tolerated. All suspected violations of academic integrity at The University of Texas at El Paso must be reported to the Office of Student Conduct and Conflict Resolution (OSCCR) for possible disciplinary action. To learn more, please visit HOOP: Student Conduct and Discipline.

GUIDANCE ON ARTIFICIAL INTELLIGENCE

AI prohibited

Use of A.I. technologies or automated tools, particularly generative A.I. 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 Student Conduct and Conflict Resolution (OSCCR).

A.I. allowed with proper acknowledgement

Use of A.I. technologies or automated tools, particularly generative A.I. such as ChatGPT or DALL-E, is only allowed with proper attribution given for its use.

Students must properly cite and give full credit to the program used upon submission of every relevant assignment. For example, text generated using ChatGPT must be cited:

Chat-GPT(version). Date of query (year/month/day). "Text of your query."
Generated using OpenAI. <https://chat.openai.com/>

A short paragraph describing how the tool(s) was/were used for the assignment must be included.

Using AI for brainstorming

Some AI technologies or automated tools, particularly generative AI such as ChatGPT or DALL-E, can be beneficial during the early brainstorming stages of an activity, and you are welcome to explore them for that purpose. However, keep in mind that AI-generated ideas are not your own and may hinder your ability to think critically and creatively about a problem. It is also important to remember that these technologies often “hallucinate” or produce materials and information that are inaccurate or incomplete—even providing false citations for use.

That said, you are not allowed to submit any AI-generated work in this course as your own. If you use any information or materials created by AI technology, you are required to cite it like you would any other source. Consider how this will affect your credibility as a writer and scholar before doing so. Any direct use of AI-generated materials submitted as your own work will be treated as plagiarism and reported to the Office of Student Conduct and Conflict Resolution (OSCCR).

ACES & Tutoring Center from the College of Engineering

Please note there are tutoring services available in the ACES center.

<https://www.utep.edu/engineering/student-resources/student-resources-aces-tutoring.html>