Syllabus

Course Information

Title: Aerodynamics I
Number: AERO 3312
CRN: 26947
Term: Spring 2023
Instructor: John Bird

Office: Engineering Building A-115
Instructor email: jjbird@utep.edu
Instructor phone: 915.747.8406
Office Hours:
Monday 16:30-1800 Tuesday 12:00-13:30 Thursday 13:30-15:00

Course Description

Basic solutions to aerospace fluid flows can shed light on more complex flows, be used to interpret the results of numerical solvers, develop intuition, guide design, and are often useful as fast approximate solutions when solving complex coupled problems (e.g. aero-structural). We will build on basic fluid mechanics, exploring some fundamental fluid flows and solution approaches relevant in aerospace applications with a special emphasis on flows relevant to aircraft flying at slow speeds.

Course Objectives

At the conclusion of this course you will be able to:

- Describe what an incompressible and inviscid flow is.
- Identify when the inviscid and imcompressible approximations are appropriate.
- Analyse flows via stream and potential functions.
- Superimpose basic flow solutions to analyse more complex flow fields.
- Use superposition and physical boundary conditions to predict the aerodynamic characteristics of aircraft.

Course Prerequisites

MECH 2311 – Introduction to Thermal-Fuid Science.

Other stuff you'll need.

Meeting Times:

Class will meet from 10:30 to 11:50 pm Tuesday and Thursday in Miners Hall room 301.

Course Communication

Office Hours:
tbd or by appointment

Email is the best way to contact me. I will attempt to respond within 24-48 hours, please include the course title or number in your email subject.

Course Resources

Required Materials

Fundamentals of Aerodynamics, Anderson.

Electronic Resources

Modern engineering practice draws heavily on electronic resources broadly available including technical papers, content from online courses, technical forums, blog posts, and wikipedia. Recognizing this, you are encourged to make *careful* use of these resources. They can be valuable references but their quality and notation can vary. Ultimately you will be tasked with developing solutions to novel problems in your careers so it is critical that an understanding of the theory of a solution is developed rather than simply stringing together code snippets from stackoverflow or bits of equations from wikipedia. There are no restrictions on the resources you makes use of, but resources must be clearly documented, including a way for me to access a resource, a description of what was obtained from each resource, and how it was used.

If you make use of anything which is not original work, you should provide a reference identifying the source of the material, a way I can access it (e.g. url) and a short explanation of what the material you obtained does and why you needed it. For example when making use of some computer code:

```
# uniformly sample initial position on earth. I knew that sampling randomly from
# latitude and longitude would over-sample the poles and under-sample the
# tropics. I figured that the earth is close enough to spherical that if I
# sampled on a sphere and normalized it to the earth's size that that would be
# close enough, but couldn't think of how to do this sampling, I found this
# solution on stackexchange and translated it from R code to matlab.
# https://stats.stackexchange.com/q/7988
n_samples = 1000
z_sample = 2 * np.random.rand(n_samples, 1) - 1
theta_sample = 2 * np.pi * np.random.rand(n_samples, 1) - np.pi
x_sample = np.sin(theta_sample) * np.sqrt(1 - z_sample**2.0)
y_sample = np.cos(theta_sample) * np.sqrt(1 - z_sample**2.0)
R_earth = 6378137.0
x = x_sample * R_earth
y = y_sample * R_earth
z = z_sample * R_earth
```

Note that you are still responsible for your solution being correct and working. For example – before I put this example in I did some basic checks (plotting the output and checking the statistics against a uniform lat-lon sample to make sure they were different).

Course Structure and Sequence

Course Format

Much of the course will consist of lectures. Each lecture will be accompanied by a reading assignment from the course text. You are expected to come to class having read this and have prepared questions that you aren't sure about. We will split course time between answering your questsions about the material, working a problem, and lecture.

Preliminaries

- coordinate systems, definitions, and terminology used in aerospace engineering
- similarity and coefficients
- basic properties and dynamics of aerospace fluids
- continuity equation
- bernoulli equation and airspeed measurement

Elementary Flows and Superposition

- streamfunction
- velocity potential
- uniform flow
- source / sink
- circulation
- doublet
- superposition to cylinder flow
- lifting cylinders
- Kutta-Joukowski theorem
- Helmholtz Theorem

Flows Around Aerodynamic Surfaces

- numerical airfoil analysis
- thin airfoil theory
- finite wings
- lifting-line theory

Assignments and Evaluation

Progress in this course will be evaluated through exercises, class discussion, and exams.

Exercises

You will be assigned regular exercise problems. These will not be scored directly. Instead you will have two opportunities for reflection and feedback.

In the first you will be asked to discuss your approach to and progress on an exercise which is not yet complete. You will have three minutes to present and two for questions, your discussion should cover:

- what do you think the key features of the problem are
- a brief sketch of how you might solve it (don't solve! you only have three minutes)
- what parts do you think might be tricky You will be expected to engage with other student's discussion in a constructive manner. Ask them or the class questions! Gently suggest something if you think they are mistaken! If you are presenting and aren't sure about something, use this to get feedback from the class on an idea!

The second opportunity will occur after the exercise is due. You will evaluate your solution against a key and a rubric. Indicate what you got wrong and discuss why. This works best if you write on your original solution with a different color. One objective is for you to not only know and understand the material, but to have an understanding of how well you know and understand it. You will complete the self assessment so that you can later compare it to feedback I provide, helping you to calibrate yourself.

My perspective on these exercises are that they exist to:

- give you a low stakes opportunity to practice
- identify conceptual or practical weaknesses in your understanding
- provide feedback on your learning to you and to me

To this end, your exercises will be evaluated on how you are engaging with these objectives, rather than on your solutions themselves. Scoring on the assignment follows this rubric:

- 0.5 for making a good faith attempt to complete the assignment
- 0.5 for honestly and comprehensively evaluating your work

Aerodynamic Thing of the Day

We will also take a few minutes during each class for the "aerodynamic thing of the day" – a short break in the middle of class where you will take turns bringing in a photo of some kind of aerodynamic-seeming doodad. Briefly (3 min) give us some context and tell us what you think it might be for (or even better, bring in something that you think is interesting but are completely stumped about!). We'll then talk about it briefly as a class. You will need to send me the photo prior to class.

Exams

You will have two exams, roughly corresponding to the first two sections of the class. Exams will be open to any static content (written and electronic references permissible, but no live communication). Unless you arrange with me prior you can only access electronic content via laptop (no cell phones). References should be cited during any development or explanation, and problems where you reference external content should have a statement at the end describing the information or insight gained from each reference.

Reference lists can be either per problem or per exam. If only written sources are used as references the list can be handwritten. If electronic resources are used then an electronic document with the references should be turned in with the exam. Note that preparing this should not be a trivial undertaking! If you are doing it right, it will take something like 10 minutes or more. It is not obvious that using electronic

resources is actually an advantage.

Further note, if you open any reference at all you will need to prepare a references statement, failure to do so constitutes academic dishonesty. Anything you look at during the exam needs to be documented. If you are observed using references that are not cited, or your references are not adequately cited you will not receive points for the problem in question. The exams will be constructed such that they can be reasonably completed in the time alotted without using references, if you are unsure about properly citing the references then plan not to use them.

Project

At the conclusion of the semester you will turn in a final project report no more than 10 total pages (excluding references).

Grade Expectations

Rubrics for evaluation of course assignments will be constructed so that:

- “C” grade level indicates a satisfactory solution to the assigned problem but without demonstrating an understanding of the theoretical background for the problem and its solution.
- “B” grade level grade will indicate both solution of the assigned problem and an understanding of its theoretical properties.
- “A” grade level grades will indicate that in addition to “C” and “B” level mastery that you understand the limitations of the solution developed.

Grade Assignment

Nominal Weights

Deliverable	**Weight**
Exercise Completion and Evaluation	0.2
Exercise Discussion / Aerodynamic Thing	0.1
Participation in Discussion	0.05
Exams	0.4
Project	0.25

Preliminary Schedule

Day	**Exercise Due**	**Topic**	**Reading**

Day	Exercise Due	Topic	Reading
2023-01-17	-	Introduction, history	-1.5
2023-01-19	-	Aerodynamic forces, basic equations	1.6-1.8
2023-01-24	-	Aerodynamic forces, basic equations (no class)	1.10-1.12
2023-01-26	1	Review of relevant mathematics (no class)	2.1-2.2
2023-01-31	-	Catchup, models of fluid	2.3
2023-02-02	2	Continuity and momentum	2.4-2.6
2023-02-07	-	Substantial derivative, flowlines	2.9-2.11
2023-02-09	3	Vorticity, circulation	2.12-2.13
2023-02-14	-	Stream function, velocity potential	2.14-2.16
2023-02-16	-	Reserved	
2023-02-21	4	Reserved / Numerical analysis	
2023-02-23	-	Exam I	
2023-02-28	-	Inviscid Flow, Bernoulli Equation	3.2-3.4
2023-03-02	-	Pressure coefficient, more inviscid intro	3.5-8
2023-03-07	6	Uniform and source flow	3.9-3.10
2023-03-09	-	Sink, doublet flow	3.11-3.12
2023-03-21	-	Cylinder, Vortex	3.13-3.14
2023-03-23	7	lift, kutta-joukowski theorem	3.15-3.18
2023-03-28	-	lift, kutta-joukowski theorem	3.15-3.18
2023-03-30	-	Exam II	
2023-04-04	8	Airfoils	4.1-4.4
2023-04-06	-	Kutta condition and circulation	4.5-4.6
2023-04-11	9	thin airfoil theory	4.7

Day	Exercise Due	Topic	Reading
2023-04-13	-	thin airfoil theory	4.8
2023-04-18	-	aerodynamic center	4.9
2023-04-20	10	finite wings and downwash	5.1-5.2
2023-04-25	-	lifting line	
2023-04-27	-	lifting line	
2023-05-02	11	stuff you ought to know	
2023-05-04	-	Reserved / Vortex Lattice	

Course Policies

Course Attendance Policy

There will be no formal attendance taken, but you are expected to be engaged in the class discussions. You will submit period reports on your engagement with the discussion.

Late Work Policy

Assignments may be accepted at my discretion provided that you contact me more than 24 hours in advance and receive an extension. Absent an emergency or prior extension, work that is simply not turned in on time will not be accepted after the deadline. If you have an emergency get in touch as soon as practical and we'll work something out.

Accommodations Policy

The University is committed to providing reasonable accommodations and auxiliary services to students, staff, faculty, job applicants, applicants for admissions, and other beneficiaries of University programs, services and activities with documented disabilities in order to provide them with equal opportunities to participate in programs, services, and activities in compliance with sections 503 and 504 of the Rehabilitation Act of 1973, as amended, and the Americans with Disabilities Act (ADA) of 1990 and the Americans with Disabilities Act Amendments Act (ADAAA) of 2008. Reasonable accommodations will be made unless it is determined that doing so would cause undue hardship on the University. Students requesting an accommodation based on a disability must register with the UTEP Center for Accommodations and Support Services (CASS). Contact the Center for Accommodations and Support Services at 915-747-5148, or email them at cass@utep.edu, or apply for accommodations online via the CASS portal.

COVID 19 Precautions

You are expected to adhere to university guidance on COVID 19 precautions available at: https://www.utep.edu/resuming-campus-operations/ Guidance and policy with respect to COVID may change throughout the semester.

If you have tested positive for COVID 19 or have reason to suspect you may have COVID 19 (e.g. because of symptoms or close contact with an individual who has COVID 19) you are expected to stay home as directed by CDC guidelines. Contact me and we will arrange appropriate accomodations.

Students who are considered high risk according to CDC guidelines and/or those who live with individuals who are considered high risk may contact Center for Accommodations and Support Services (CASS) to discuss temporary accommodations for on-campus courses and activities.

Academic 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 ones' 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.

Aerodynamics I
Aerodynamics I