AME 261: Flight Dynamics

Units: 4
Term: Spring 2025   Jan 13th – May 2nd

Location	Lecture: Tue/Thu 10–11:50am, SOS B4
	Discussion: Fri 2–2:50pm, ZHS 352
	See course Brightspace and Piazza pages
Instructor	Saakar Byahut
Office	OHE 500N
Office Hours	Mon 4:30–6:30pm, Tue 2:30-4:30pm
	and by appointment
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Teaching Assistant	Madeleine Oliver
Office	VHE 202
Office Hours	Wed 10am-12pm, Thu 2-4pm
Contact Info	moliver4@usc.edu

Course Description

Concepts and analysis methods regarding performance of atmospheric and space flight vehicles; maximum speed, rate-of-climb, range, and endurance; basic stability and control, weight and balance; orbital mechanics; jet and rocket engine propulsion; computer exercises

Learning Objectives

By the end of this course, students will be able to:

- Model performance of aircraft, including writing equations that incorporate the effects of lift, drag, thrust, and weight
- Plot curves to represent climbing and turning performance as aircraft design and atmospheric parameters are varied
- Estimate the range and endurance of aircraft
- Understand and apply longitudinal stability equations to design control surfaces for aircraft
- Apply equations of orbital motion and model performance of spacecraft at launch, orbit, and re-entry

Recommended Preparation: AME 105, AME 201, PHYS 151, Intro to Computer Programming

Textbook   Anderson Jr., John D. Introduction to Flight, 9th Edition. McGraw-Hill. (**required**)
ISBN-10: 0078027675; ISBN-13: 9780078027673. (*7th, 8th and international editions ok*)

Grading   30% Homework | 10% Quizzes & Class Participation | 30% Design Project |
30% Exams (3 of unequal weight)
An extra 5% will be added to the final grades of the top 3 student answerers on Piazza.

Piazza

This course will use Piazza for all class discussions. Please refrain from emailing questions related to assignments, midterms, etc., and instead use Piazza. The instructor, the TA, and even you can answer questions as they arise, thus providing an efficient means for communication. If you have issues accessing the Piazza, contact team@piazza.com directly.

Exams   There will be three exams as noted in the schedule. Please note the exam dates on your calendar now. All exams will be open notes unless stated otherwise. They will be counted unequally, with the lowest-scoring exam counting for 5% of the final grade, the next highest 10%, and the highest 15%.

Project   A group **Design Project** will be initiated towards the middle of the semester. Each group will be required to design several aspects of an aircraft within given constraints. Details will be discussed further during class.

Software   **MATLAB**: http://software.usc.edu/
MS Office (Word, Excel): https://itservices.usc.edu/officestudents/
These programs are also available in all USC computer labs. Install before class begins.

Calculator   Required. Calculators are allowed for use during all quizzes and exams.

Course Schedule

Week	Dates	Topics	Reading (9th Edition)
1	Jan 13-17	Review of AME 105 Material (Standard Atmosphere, Aerodynamics, Drag, Wings, Boundary Layers, Turbulence, Mach Number, Cp)	Ch. 1 – 5
2	Jan 20-24	Emax, VDmin and power requirements	Ch. 6.1-6, 6.26, 9.1-9.6
3	Jan 27-31	Altitude effects, climbing flight, ceiling, and gliding flight	Ch. 6.7-10 & notes
4	Feb 3-7	Range, optimum cruise altitude and endurance	Ch. 6.11-14 & notes
5	Feb 10-14	Cruise at different altitudes, speeds, and angles of attack	Ch. 6.11-14 & notes
6	Feb 18	Compressibility, Mach effects, wave drag and swept wings	Ch. 5.8-12, 5.16 & notes
	Th Feb 20	**Exam #1**	
7	Feb 24-28	Takeoff performance	Ch. 6.15 & 5.17
8	Mar 3-7	Landing performance	Ch. 6.15-16
9	Mar 10-14	Turning flight	Ch. 6.17-23 & notes
10	*Mar 17-21*	*Spring Break*	
11	Mar 25	Aircraft moments, stability criteria and partial derivatives	Ch. 7.1-4
	Th Mar 27	**Exam #2**	
12	Mar 31-Apr 4	Longitudinal static stability, Effects of wings, tail and canards; Trim, stick free;	Ch. 7.5-14 & notes
13	Apr 7	Stability & Control	Ch. 7.15-23 & notes
	Th Apr 10	*No class, time to work on design project*	
14	Apr 14-18	Space vehicles, orbit equation	Ch. 2.7 & Ch. 8.1, 8.4
15	Apr 21-25	Kepler's laws, atmospheric re-entry, rocket propulsion	Ch. 8.5-17 & 9.7-8
16	Apr 28	Rocket propellants, rocket staging, electric propulsion	Ch 9.9-13
	Th May 1	**Exam #3**	
	Th May 8	**Design Project Final Report, Due before midnight**	

Description and Assessment of Assignments

Homework will be assigned almost every week. **All assignments are due on Tuesday before midnight PT, are to be submitted to GradeScope using the templates provided on Brightspace.** Approximately half of the homework will involve the use of a computer and will require graphical results. All students should be familiar with the university computer labs; alternatively, a personal computer can be used to solve the assignments. Homework will not be accepted late for unexcused reasons. Please do not attempt to complete your assignment the night before it is due because most problem sets require more than one evening worth of work.

All assignments are due <u>before</u> the stated deadline. **One microsecond ($1\ \mu s$) late is considered late and there are no exceptions.** Absences or late work for medical reasons must be justified with some verifiable evidence.

To receive credit for your work, all homework, quiz and exam problems must be presented in a clear, organized manner. Solutions must show evidence of work; "magic" answers will not be accepted. Partial credit may be given if the solution is presented in a logical fashion.

Students may work together on the homework by helping each other to discuss the problems, review the lectures, set up the problems, etc. **However, when you sit down to write a computer program or solve the homework problems, each student must do that individually.** You may also discuss each other's computer programs but <u>**under no circumstances should you copy anyone's work**</u>. **D<small>O NOT SHARE OR EMAIL ANYTHING</small>**; this goes for all courses at USC. **Failure to comply with this requirement will result in an F for the course.** All students should <u>read and understand</u> the **Academic Conduct** section at the end of this document.

There are office hours throughout the week to help you with the course material; this time is best utilized when students come prepared with an attempt at a solution, thus allowing us to help you through your thought process.

There are no makeup assignments or makeup exams. The lowest homework grade will be dropped from your total score; use this to your advantage if you have an upcoming schedule conflict. There are three exams; two highest exam scores will count towards the final grade. Everything else will count towards the final grade.

Homework Solutions – Rules and Tips

Technical communication is an extremely important skill required of all engineers. If you cannot present your work well to your boss or co-workers, do not expect a raise! Likewise, if you cannot present your technical work well in this class, you will not get a good grade on your assignments. Thus, all homework **must** be presented in a professional manner. Follow the guidelines below:

1. All homework must be submitted through GradeScope and organized into the format specified in the templates provided on Brightspace. Emailed submissions <u>will not be accepted</u>. Ensure your name is printed on your assignments.
2. Make sure mistakes are clearly erased or carefully crossed out so that anyone can read and follow your work without difficulty. If the grader cannot follow your logic or your work is messy, the homework will be returned to you ungraded and a score of zero recorded.
3. It is <u>necessary</u> that you present your work <u>neatly</u>, <u>logically</u> and <u>professionally</u>. To receive full credit on homework and exam problems **all** the following **must** be shown:
   a) Write down all given **data** at the beginning of the problem solution.
   b) Include a **free hand sketch** of the problem whenever possible.
   c) State any **assumptions** used in the problem.
   d) Write the equations to be used in **symbolic form**. Indicate where you obtained the equations and verify that the assumptions embedded within the equations are consistent with the problem you are attempting to solve. Manipulate the equations in **symbolic form** to obtain the desired form **before** substituting in the numerical values (see example problems 4.3 and 4.4 in your book). **No exceptions!**
   e) **Algebraic steps** are an important part of your work and should be shown. Again, no exceptions.
   f) Work through the **Units** in your calculations and show conversion of the units as needed. Be sure to give <u>BOTH THE NUMERICAL VALUE AND THE UNITS</u> in your answer. Why? Because $4 \neq 4$ m/s.
   g) Round off the final numbers and report only **Significant Digits** consistent with the accuracy of the data (*i.e.*, if the data are given to 3 significant digits, <u>DO NOT</u> present an answer with 8 significant digits). If some of the data have only one digit given, *e.g.* angle of attack $\alpha = 8$ degrees, you should assume that two digits are implied (*i.e.*, $\alpha = 8.0°$). In this case, your answer should contain only two significant digits although three significant digits will be accepted. Generally, you should have three significant digits in your answer unless you can justify more or less based upon the given data.

4. Remember that the most important aspect of homework and exam solutions (typically 80-90% of the grade for the problem) is **the method** and not the correct answer. Thus, indicate how the solution was obtained by showing each step in the solution and where the data were acquired.

5. **Place a box around your answer to clearly indicate your final solution.**
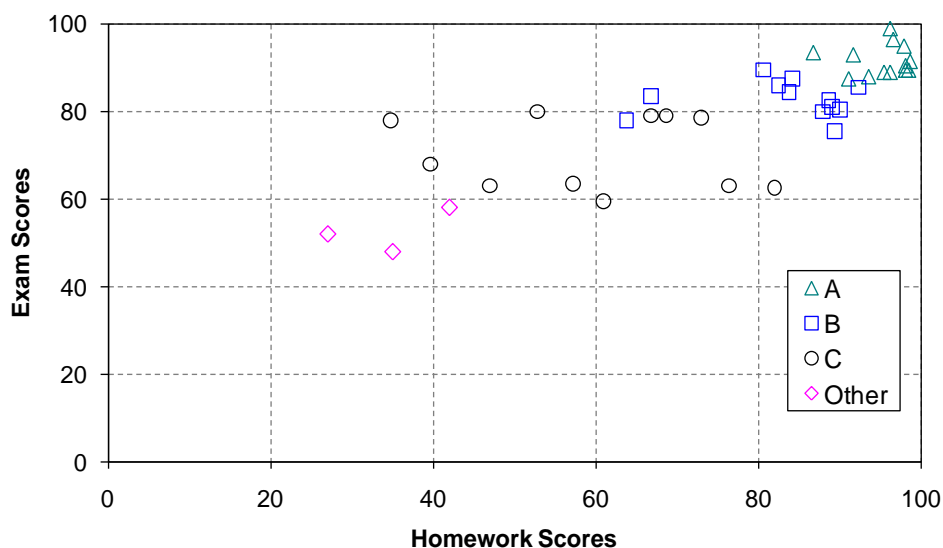
Figure 1. Correlation between Homework and Exam scores

Figure 1 is provided to show the relationship between the homework scores (normalized to 100 points) and the grades on the exams. This data is from a previous semester but the trend is consistent year after year. Note, there is a strong correlation between how well students do on their homework and their exams; do not think that the homework is inconsequential. If you are having trouble, seek help either by seeing the instructor, the teaching assistants or get additional tutoring (Viterbi Academic Resource Center). Secondly, data over the past several year's shows that about one third of the students in the class earn an A, one third earn a B and the remaining third earn a C or lower. Lastly, looking at the individual homework scores (not shown), the lower scores were primarily due to students not submitting several of their assignments; it was not because they did poorly on all of their assignments. **Hence, be sure that you complete, understand the concepts within and turn in ALL of your homework if you want an A or B in the course.**

Academic Conduct

Plagiarism – presenting someone else's ideas as your own, either verbatim or recast in your own words – is a serious academic offense with serious consequences. Familiarize yourself with the discussion of plagiarism in *SCampus* in Section 11, *Behavior Violating University Standards* https://scampus.usc.edu/b/11-00-behavior-violating-university-standards-and-appropriate-sanctions/, and **view the guidelines in Appendix A at the end of this document**. Other forms of academic dishonesty are equally unacceptable. See additional information in *SCampus* and university policies on scientific misconduct, http://policy.usc.edu/scientific-misconduct.

Discrimination, sexual assault, and harassment are not tolerated by the university. You are encouraged to report any incidents to the *Office of Equity and Diversity* http://equity.usc.edu or to the *Department of Public Safety* http://capsnet.usc.edu/department/department-public-safety/online-forms/contact-us. This is important for the safety of the whole USC community. Another member of the university community – such as a friend, classmate, advisor, or faculty member – can help initiate the report, or can initiate the report on behalf of another person. *The Center for Women and Men* http://www.usc.edu/student-affairs/cwm/ provides 24/7 confidential support, and the sexual assault resource center webpage http://sarc.usc.edu describes reporting options and other resources.

Support Systems

Counseling and Mental Health - (213) 740-9355 – 24/7 on call   studenthealth.usc.edu/counseling
Free and confidential mental health treatment for students, including short-term psychotherapy, group counseling, stress fitness workshops, and crisis intervention.

National Suicide Prevention Lifeline - 1 (800) 273-8255 – 24/7 on call
suicidepreventionlifeline.org
Free and confidential emotional support to people in suicidal crisis or emotional distress 24 hours a day, 7 days a week.

Relationship and Sexual Violence Prevention Services (RSVP) - (213) 740-9355(WELL), press "0" after hours – 24/7 on call
studenthealth.usc.edu/sexual-assault
Free and confidential therapy services, workshops, and training for situations related to gender-based harm.

Office of Equity and Diversity (OED) - (213) 740-5086 | Title IX – (213) 821-8298
equity.usc.edu, titleix.usc.edu
Information about how to get help or help someone affected by harassment or discrimination, rights of protected classes, reporting options, and additional resources for students, faculty, staff, visitors, and applicants.

Reporting Incidents of Bias or Harassment - (213) 740-5086 or (213) 821-8298
usc-advocate.symplicity.com/care_report
Avenue to report incidents of bias, hate crimes, and microaggressions to the Office of Equity and Diversity |Title IX for appropriate investigation, supportive measures, and response.

The Office of Disability Services and Programs - (213) 740-0776
dsp.usc.edu
Support and accommodations for students with disabilities. Services include assistance in providing readers/notetakers/interpreters, special accommodations for test taking needs, assistance with architectural barriers, assistive technology, and support for individual needs.

USC Campus Support and Intervention - (213) 821-4710
campussupport.usc.edu
Assists students and families in resolving complex personal, financial, and academic issues adversely affecting their success as a student.

Diversity at USC - (213) 740-2101
diversity.usc.edu
Information on events, programs and training, the Provost's Diversity and Inclusion Council, Diversity Liaisons for each academic school, chronology, participation, and various resources for students.

USC Emergency - UPC: (213) 740-4321, HSC: (323) 442-1000 – 24/7 on call
dps.usc.edu, emergency.usc.edu
Emergency assistance and avenue to report a crime. Latest updates regarding safety, including ways in which instruction will be continued if an officially declared emergency makes travel to campus infeasible.

USC Department of Public Safety - UPC: (213) 740-6000, HSC: (323) 442-120 – 24/7 on call
dps.usc.edu
Non-emergency assistance or information.

Tutoring is available for this course through https://viterbiundergrad.usc.edu/academics/. A number of USC's schools provide support for students who need help with scholarly writing. Check with your advisor or program staff to find out more. Students whose primary language is not English should check with the *American Language Institute* http://dornsife.usc.edu/ali, which sponsors courses and workshops specifically for international graduate students. *The Office of Disability Services and Programs* http://dsp.usc.edu/ provides certification for students with disabilities and helps arrange the relevant accommodations. If an officially declared emergency makes travel to campus infeasible, *USC Emergency Information* http://emergency.usc.edu will provide safety and other updates, including ways in which instruction will be continued by means of Brightspace, teleconferencing, and other technology.

Appendix A: Academic Dishonesty Sanction Guidelines

Violation	USC - Recommended Sanction for Undergraduates*	AME - Recommended Sanction for Undergraduates and Graduates
Copying answers from other students on any course work.**	F for course.	First offense: **F** on assignment. Second offense: **F** for course.
One person allowing another to cheat from his/her exam or assignment.	F for course for both persons.	If assignment: First offense: **F** on assignment. Second offense: **F** for course. If exam: **F** for course.
Possessing or using material during exam (crib sheets, notes, books, etc.) which is not expressly permitted by the instructor.	F for course.	First offense: **F** on exam. Second offense: **F** for course.
Continuing to write after exam has ended.	F for course.	**F** on exam
Taking exam from room and later claiming that the instructor lost it.	F for course and recommendation for further disciplinary action (possible suspension).	**F** for course
Changing answers after exam has been returned.	F for course and recommendation for further disciplinary action (possible suspension).	**F** for course
Fraudulent possession of exam prior to administration.	F for course and recommendation for suspension.	**F** for course
Obtaining a copy of an exam or answer key prior to administration.	Suspension or expulsion from the university; F for course.	**F** for course
Having someone else complete course work for oneself.	Suspension or expulsion from the university for both students; F for course.	**F** for course
Plagiarism — Submitting other's work as one's own or giving an improper citation.	F for course.	First offense: **F** on assignment. Second offense: **F** for course.
Submission of purchased term papers or papers done by others.	F for course and recommendation for further disciplinary action (possible suspension).	**F** for course
Submission of the same assignment to more than one instructor, where no previous approval has been given.	F for both courses.	**F** for both courses
Unauthorized collaboration on an assignment.	F for the course for both students.	First offense: **F** on assignment. Second offense: **F** for course.
Falsification of information in admission applications (including supporting documentation).	Revocation of university admission without opportunity to reapply.	Revocation of university admission without opportunity to reapply.
Documentary falsification (e.g., petitions and supporting materials; medical documentation.)	Suspension or expulsion from the university; F for course when related to a specific course.	Suspension or expulsion from the university; F for course when related to a specific course.
Plagiarism in a graduate thesis or dissertation.	Expulsion from the university when discovered prior to graduation; revocation of degree when discovered subsequent to graduation.***	Expulsion from the university when discovered prior to graduation; revocation of degree when discovered subsequent to graduation.***

*Assuming first offense
**Exam, quiz, tests, assignments or other course work.
***Applies to graduate students