ENAE404
Space Flight Dynamics
Syllabus
Spring 2025

Department of Aerospace Engineering
The University of Maryland

Instructor: Prof. Brent Wm. Barbee
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Office: EGR 3400
Office hours: Tu: 1:30–2:30 PM
Class meeting location and time: CHE 2110; Tu, Th: 9:30–10:45 AM

TA: Tom Bone, tbone@umd.edu
TA: Anmol Sikka, sikka@umd.edu

TA Office hours:

- Tom: Wednesdays, 12:00–1:00 PM / Location TBD

- Anmol: Thursdays, 11:00 AM–12:00 PM on Zoom -
  https://umd.zoom.us/j/7229770189?pwd=dzdwNk45OVZHeHJSNXFyMFZnT3V2QT09&omn=96543955167, Meeting
  ID: 722 977 0189 Passcode: 473862

Virtual Participation: In-person participation in class meetings and office hours is encouraged and expected, but if a student's circumstances necessitate it (illness, unavoidable travel, etc.) then virtual participation will also be possible using the connection information given below. Please inform the professor ahead of time if you need to participate virtually on a particular date.

https://umd.zoom.us/j/2226271754?pwd=RWhyUnUxMG1Hc2IvcHJMTWwrWXpodz09
Passcode: 881115

Required Texts:

Fundamentals of Astrodynamics, Bate, Mueller and White, ISBN: 0486600610
Analytical Mechanics of Space Systems, Schaub and Junkins, ISBN: 1624105211

Additional Recommended Texts:

The following textbooks are not required but are good additional references:

An Introduction to the Mathematics and Methods of Astrodynamics, Battin, ISBN: 1563473429
Orbital Mechanics, Chobotov, ISBN: 1563475375
Modern Spacecraft Dynamics & Control, Kaplan, ISBN: 0471457035
Numerical Recipes in C: The Art of Scientific Computing, Press, ISBN: 0521431085
Fundamentals of Astrodynamics and Applications, Vallado, ISBN: 1881883183
Space Vehicle Dynamics and Control, Wie, ISBN: 1563479532
Spaceflight Dynamics, Wiesel, ISBN: 0070701105

Prerequisites: ENAE301

Note: At least some experience with a computer programming language (e.g., MATLAB) is highly recommended. Students are free to use any programming language but must be able to generate data plots. The instructor can provide code debugging help with C and MATLAB.

Course Description:
Three-dimensional motion under central fields. Solutions to orbital motion, orbital elements, time elements. Kepler's laws. Orbital maneuvering, rendezvous and station-keeping. Rigid-body attitude dynamics, spacecraft attitude dynamics.
The UMD ELMS (Canvas) website for this course can be accessed by logging into:
https://umd.instructure.com/login

Communication Outside the Classroom & Emergency Protocol
ELMS announcements is the primary means of communication with students outside of the classroom. Class cancellations, changes in class meeting time/location, and other timely announcements will be communicated via ELMS. Additionally, if the University is closed for an extended period of time for any reason, the instructor will use ELMS to communicate with students regarding continuation/completion of the course.

Course Topics

The following is an overview of the topics that the instructor intends to cover throughout the semester.

- The restricted two-body problem
    - Conserved quantities
    - Orbital elements
    - Cartesian / orbital element conversions
    - Kepler's laws / Kepler's Equation
- Ground Tracks
- Coordinate frames & Frame transformations
- Hohmann Transfer
- Maneuvers (tangential, non-tangential)
- Patched conics
- Planetary gravity assist flybys
- Lambert's Problem
- Initial Orbit Determination
- The ideal rocket equation
- Spacecraft attitude dynamics
    - Quaternions & Euler angles
    - Rigid body motion
    - Polhodes & torque-free motion
    - Peturbations
    - Gravity gradient

Assignments and Grading

Grading Procedures:

Midterm 1 + Midterm 2: 35%
Homework: 35%
Final Exam: 30%

Homework:

There will be 9 homework assignments. Homework assignments are due at the beginning of a class period and must be submitted via **Gradescope**. For coding assignments, DO NOT publish your code in Matlab. Please put the figures and any required explanation in a word document and then place the printed (save as pdf or print to pdf) .m files at the end of this document. Late homework will not typically be accepted.

Exceptions to the "no late homework" policy:

1. If students have a major life event (death in the family, homelessness, major illness, etc) that impedes their ability to submit the homework, they should contact the instructor as soon as possible.

2. Each student will be allowed one excused late homework, which is to be submitted, **via Gradescope**, no more than 24 hours after the original due date. The instructor will keep track of which students have used their one excused late homework pass, and any subsequent late homework assignments will receive a grade of zero.

Homework is assigned to give students the opportunity to practice problem solving techniques and to demonstrate their knowledge in a less stressful environment than an exam. **Homework must be a neat and professional product. Five "style points" may be awarded by the instructor/TA/TF/grader on every homework.** In order to receive all style points:

1. Questions should be answered in the order they are presented.

2. Answers should be boxed or underlined.

Points will be deducted if the homework submission does not meet the previously described level of neatness or is illegible. The following link is a compact guide to formatting homework in LaTeX that you may copy for your own use and submission: https://www.overleaf.com/read/tsdqkjmvhqrp.

Extra Credit:

Students may receive extra credit through the following activities:

1. Attend a space-related technical seminar as part of the Aerospace Engineering Seminar Series and write a typed 1 page, single-spaced report on the seminar. Alternate seminars identified by students may be acceptable, but must be pre-approved by the instructor. The report should include the seminar title and speaker's name. The report should contain the following information: a summary of the material presented, a discussion of how the seminar relates to the course (if not immediately obvious), and a discussion of something in the seminar that the student found interesting. Reports will be graded based on the student's demonstrated understanding of the material, as well as writing quality (sentence structure, spelling errors, etc). Plagiarism will not be tolerated. Reports must be submitted on ELMS.

2. Get STK or FreeFlyer Certified. Students may complete the Level 1 and/or Level 2 training. In order to get the extra credit, students should submit a copy of their certificate to the appropriate folder on ELMS. Please begin your STK certification process early, as it takes some time (1wk) for the certificate to be issued. For STK: https://www.agi.com/training/, For FreeFlyer: https://ai-solutions.com/freeflyer-astrodynamic-software/freeflyer-certification.

3. Other, as specified by instructor. Additionally, students may propose extra credit activities to the instructor. All extra credit activities (except STK/FreeFlyer certification) must include a technical writing component.

All Extra Credit must be submitted on or before **May 1**. Students may complete up to two extra credit projects. Each extra credit project will be worth up to 4 points added to the midterm exam scores. The maximum extra credit that can be received is 8 points = 2.8% on the final grade.

Important Dates

- First Day of Class 2025-01-28 (Tuesday)

- Midterm Exam 1, 2025-03-04 (Tuesday), 9:30–10:45 AM

- Midterm Exam 2, 2025-04-17 (Thursday), 9:30–10:45 AM

- Optional Extra Credit Work Due 2025-05-01 (Thursday)

- Last Day of Class 2025-05-13 (Tuesday)

- Reading Day 2025-05-14 (Wednesday)

- Final Exams Begin 2025-05-15 (Thursday)

- Our Final Exam Date 2025-05-16 (Friday), 10:30 AM –12:30 PM

- Final Exams End 2025-05-21 (Wednesday)

Attendance

Regular attendance and participation in this class is the best way to grasp the concepts and principles being discussed. All lectures will be recorded, and students that miss class should plan to watch the recorded lectures online. In the event that a class must be missed due to an illness, UMD's policy on excused absence applies (https://policies.umd.edu/assets/section-v/V-100G.pdf). The following are some key points:

1. For every medically necessary absence from class, a reasonable effort should be made to notify the instructor in advance of the class. When returning to class, students must bring a note identifying the date of and reason for the absence, and acknowledging that the information in the note is accurate.

2. If a student is absent more than one time, the instructor may require documentation signed by a health care professional.

3. If a student is absent on days when assignments are due, the student is required to notify the instructor in advance, and upon returning to class, bring documentation of the illness, signed by a health care professional.

If a student must be absent due to extenuating circumstances that are not medical in nature, the student must discuss the absence with the instructor in advance and will be responsible for class material covered while absent. Multiple repeated absences for non-medical reasons are not permitted. Finally, the instructor may cancel or reschedule class meetings in advance on a very limited basis for logistical reasons.

Academic Integrity

The University of Maryland has a Code of Academic Integrity, available on the web at https://www.president.umd.edu/sites/president.umd.edu/files/documents/policies/III-100A.pdf. We assume that students are familiar with the principles of the Code, which prohibits cheating on exams, plagiarizing papers, submitting the same paper for credit in two courses without authorization, buying papers, submitting fraudulent documents, and forging signatures. Students who have questions or concerns about these issues should contact the instructors or view the website for additional information.

The University of Maryland, College Park's nationally recognized Code of Academic Integrity is administered by the Student Honor Council. This Code sets standards for academic integrity at Maryland for all undergraduate and graduate students. As a student you are responsible for upholding these standards for this course. It is very important for you to be aware of the consequences of cheating, fabrication, facilitation, and plagiarism. For more information on the Code of Academic Integrity or the Student Honor Council, please visit http://www.shc.umd.edu or http://www.studentconduct.umd.edu.

To further exhibit your commitment to academic integrity, remember to sign the Honor Pledge on all of your work:

I pledge on my honor that I have not given or received any unauthorized assistance on this assignment/examination.

Statement on Civility

The University of Maryland and the A. James Clark School of Engineering is expected to be a diverse, open, and tolerant environment within which all ideas, whether popular or not, may be freely discussed without rancor. The instructor of this course is committed to creating an open and accepting environment in which diversity, unique perspectives, and others' world views are respected. Demeaning, intimidating, or threatening behavior is unacceptable

and contrary to our basic values and may violate campus policies on student conduct and behavior. As citizens of the university, we take the lead in producing, and take pride in sustaining, an environment that is characterized by tolerance, respect, and civility. This is the hallmark of a university and college that welcomes and values diverse perspectives, intellectual pluralism, and the free and open exchange of ideas.

Non-Discrimination

This course strives to establish a classroom climate that values diverse perspectives and experiences while working toward shared academically rigorous goals. The University of Maryland, College Park affirms its commitments to a policy of eliminating discrimination on the basis of race, color, creed, sex, gender identity or expression, sexual orientation, marital status, personal appearance, age, national origin, political affiliation, physical or mental disability, or on the basis of the exercise of rights secured by the First Amendment of the United States Constitution. This Code is established to prevent or eradicate such discrimination in accordance with due process within the Campus community. In doing so, the Campus recognizes that it must strive actively and creatively to build a community in which opportunity is equalized. To read the entire policy, see appendix A in the undergraduate catalogue. The University's Strategic Plan For Diversity is available here: https://issuu.com/umaryland/docs/22628.

Reporting and Confidential Services

The University of Maryland is committed to providing support and resources, including academic accommodations, for students who experience sexual or relationship violence (as defined by the University's Sexual Misconduct Policy). To report an incident and/or obtain an academic accommodation, contact the Office of Civil Rights and Sexual Misconduct at 3014051142. If you wish to speak with someone confidentially, contact Campus Advocates Respond and Educate (CARE) to Stop Violence at 3017413555. Disclosures made to faculty are not confidential and must be reported to the Office of Civil Rights and Sexual Misconduct. For more information visit https://ocrsm.umd.edu.

Students with Disabilities

Any students with disabilities should inform the instructor as soon as possible so that appropriate arrangements can be made according to University policy.

Holidays, Religious and Otherwise

- Spring Break 2025-03-16 (Sunday) through 2025-03-23 (Sunday)

It is the student's responsibility to inform the instructor of any intended absences for religious observances in advance. Prior notification is especially important in connection with final examinations, since failure to reschedule a final examination before the conclusion of the final examination period may result in loss of credits during the semester.

Copyright Notice

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