AEE 462: Space Vehicle Dynamics and Control

Syllabus

Instructor: M. Peet
Meeting Time: TTh 6:00-7:15 in SHESC 340
Office Hours: F 4:00-4:30
UGTA Office Hours: TBD
Hourly TA Office Hours: TBD

Instructor Matthew M. Peet, Associate Professor of Aerospace Engineering. Office: ERC 253. `email:` mpeet@asu.edu.

Direct Link to Zoom Room (Class and Office Hours) https://asu.zoom.us/j/2031490735

Undergraduate Teaching Assistants Dhruv Jain (dnjain2@asu.edu), Kieran Shields (kbshield@asu.edu)

Hourly Teaching Assistant Gabino Rodriguez (gmarti42@asu.edu)

Graders Kyle Gossett (kgosset1@asu.edu), Kristian Peterson (krpete17@asu.edu)

Content *Spacecraft Dynamics:* Orbits and Orbital Elements. Orbital Insertion and Transfer. Interplanetary Mission Planning. Spacecraft Tracking and Targeting. Rigid Body Dynamics and Control.

Course Structure This class will include both in-person and online components. The online component will consist of recorded lectures. Each Lecture will be posted on the canvas site and linked to my Youtube channel. 4-6 Disputation questions (theses) will then be posted on canvas at the same time as posting of the lecture. The in-person component will consist of an in-class disputation session. Each student will be assigned to either a Tuesday or Thursday disputation section. All students should then read the disputation questions and view both lectures prior to their assigned in-person component. Attendance at the assigned disputation section is MANDATORY and students will be strongly penalized for failure to attend. During the disputation section, we will employ the disputation lecture format. All students should be prepared to both support or oppose all theses posed by the instructor and to support their response using material from the lecture slides, cogent arguments, and outside sources in accordance with the disputation guidance given in class and posted separately on canvas. Students will be assigned to teams, with one team supporting and one team opposing each thesis statement. Two students from each team will present points in favor of or opposed to the thesis. Following initial arguments, two other students from each team will then attempt to rebut or dispute argument given by the other team. Finally, the floor will be opened for all students to participate. Students participating online and from abroad will also we required to attend this lecture and to answer questions and engage in disputation. Details of this structure are subject to change as becomes necessary due to the large class size and other factors.

Classroom Behavior For those participating online, students are required to have high-speed internet, a high-quality videocamera and a high-quality microphone. Your video feed must be active at all times during class and the camera should be directed at your face at all times. Furthermore, you should be seated at a desk with no ambient background noise. You should be actively following the class disputation at all times and not doing other activities such as browsing the internet, doing homework, or playing games. Failure to abide by these guidelines will result in loss of credit for your disputation.

Participation Attend class. Prior to disputation, students will be invited to ask questions. Even mildly off-topic questions.

Class Discord Server We will be using discord as a free alternative to Slack. You should download the discord app and subscribe to the course server. There will be a separate channel for questions about each lecture. students, TA's and ultimately the instructor should monitor these channels and be proactive about answering questions. Please check the discord channel to see if your question has already been answered and follow-up if the response is insufficient. There will also be a general question channel and HW question channel.

Late Homework Policy Homework turned in late, in general will not be graded. However, there may be some exceptions to this rule if none of the problems have been discussed in class. In this case between 50% (2-3 days late) and 70% (0-1 days late) credit will be awarded.

Textbook The textbook is "Orbital Mechanics" by J. E. Prussing and B. A. Conway, 2nd edition. This book has several important errata which should be corrected prior to use. For a list or errata, see `http://prussing.ae.illinois.edu/Errata.2ed.pdf`. This is an entry-level textbook, however, it is relatively terse. Some students prefer "Orbital Mechanics for Engineering Students" by Curtis, and I encourage you to consult this optional textbook. In addition, anyone wishing to pursue or apply the topics we cover in more depth should refer to "Fundamentals of Astrodynamics and Applications" by D. A. Vallado. This textbook has detailed descriptions of many of the algorithms used in modern orbital mechanics and astrodynamics. Unfortunately, there is no textbook for the attitude dynamics portion of this course. However, students may consult "Spacecraft Attitude Dynamics" by P. C. Hughes - an inexpensive Dover publication.

Schedule Class will meet TTh 6:00-7:15 PM. There will be a mid-term examination and a final examination. Assignments will be given approximately bi-weekly.

Prerequisites MAE 318 with a grade of 'C' or better. Access to Matlab (ASU has a site-license).

Internet Resources All lecture slides and videos will be posted on Canvas. All homework assignments will be posted on Canvas and should be submitted via Gradescope. Announcements will be posted on canvas, so please monitor these regularly. A complete (but unofficial) set of lecture notes for the previous incarnation of this class is available online at `http://control.asu.edu`.

Evaluation Homework will be the basis for 25% of the grade. Problem sets will be given on a bi-weekly basis. An in-class midterm and an in-class final exam will be given, each for 30% of the grade. The quality of disputation answers will account for 15% of the grade. **Note:** Grade distribution will be relative to the performance of the class as a whole and cutoffs are at the discretion of the instructor.

Academic Integrity Policy Discussion of the homework problems is permitted, although the writing must be independent - NO COPYING. Use or even possession of a SOLUTIONS MANUAL or Previous Homework Solutions in any way is prohibited and violations will be reported to Designated Dean for Academic Discipline and MAE Chair of the Academic Honesty Committee. Warning - solutions manuals and Solutions have built-in errors to detect copying. Cheating on exams will result in automatic failure of the course and referral of the student to Designated Dean for Academic Discipline and MAE Chair of the Academic Honesty Committee. Cheating is BAD. Do not cheat.

Violence See the Student Services Manual, SSM 104-02, "Handling Disruptive, Threatening, or Violent Individuals on Campus"

Disabilities A reminder to students that when requesting accommodation for a disability, they must be registered with the Disability Resource Center (DRC) and submit appropriate documentation from the DRC

Absence Policy Attendance at all in-person lectures is required. Exceptions include excused absences related to university sanctioned events/activities that are in accord with ACD 304-02, “Missed Classes Due to University-Sanctioned Activities” and excused absences related to religious observances/practices that are in accord with ACD 304-04, “Accommodation for Religious Practices”. In general, late homework will not be graded and missing examinations cannot be retaken. Exceptions include excused absences related to university sanctioned events/activities that are in accord with ACD 304-02, “Missed Classes Due to University-Sanctioned Activities” and excused absences related to religious observances/practices that are in accord with ACD 304-04, “Accommodation for Religious Practices”

Lectures Lectures will cover the following topics.

Lecture 1 - History of Orbital Mechanics

Lecture 2 - The N-body problem: Invariants

Lecture 3 - The Two-Body Problem: Elliptic Orbits

Lecture 4 - Position and Velocity

Lecture 5 - Hyperbolic Orbits

Lecture 6 - The Orbital Plane

Lecture 7 - Converting to and from r and v

Lecture 8 - Relative Motion

Lecture 8 - Rocketry: Δv

Lecture 9 - Impulsive Orbital Maneuvers

Lecture 10 - Targeting

Lecture 11 - Targeting

Lecture 12 - Bi-elliptics and Out-of-Plane Maneuvers

Lecture 13 - Orbit Perturbations

Lecture 14 - The Effect of a Non-Spherical Earth

Lecture 15 - Interplanetary Mission Planning

Lecture 16 - Orbit Determination

Lecture 17 - Rigid-Body Dynamics

Lecture 18 - Torque-Free Motion

Lecture 19 - Stabilization