EAS4510 - Astrodynamics Fall 2025

COURSE INSTRUCTOR

Name: Dr. Anil V. Rao Office: MAE-A 314

E-mail: anilvrao@ufl.edu Tel: 352-392-5523 (Office); (352) 672-1529 (Mobile).

YouTube Channel: https://www.youtube.com/user/anilvrao2

All contact methods are acceptable! Note for fastest response it is best to reach me on my mobile phone.

TEACHING ASSISTANTS/PEER MENTOR/SUPERVISED TEACHING ASSISTANT (Please Contact Through Canvas Website)

Name: Katrina Winkler Contact: Via Canvas Site

Office Location: Available via Zoom Name: Wanjiku Kanjumba

Contact: Via Canvas Site Office Location: Available via Zoom

Class Period: MWF 12:50 PM - 1:40 PM (Period 6). Attendance is expected and will be taken at random

Lecture Room: MAE-A (Building 725) Room 303

Online Videos: Click here for Astrodynamics Playlist (On My YouTube Channel) Office Hours Zoom Link:

 Meeting ID: 982 4779 1909 • Click here for Zoom link or copy and paste the following URL into your browser: https://ufl.zoom.us/j/98247791909

COURSE LOCATIONS AND CLASS PERIODS

CATALOG DESCRIPTION

Introduces the solar system. Includes study of two-body motion, Hohmann transfer, patched conics for interplanetary and the restricted three-body problem. Also includes an introduction to powered flights and artificial satellite orbits.

PREREQUISITES

EGM 3401 with minimum grade of C and (EGM 4313 or MAP 4305 or MAP 5304).

ABET OUTCOMES

OUTCOMES COVERAGE 1. An ability to identify, formulate, and solve complex engineering problems High by applying principles of engineering, science, and mathematics

2. An ability to apply engineering design to produce solutions that meet specified needs with consideration of public health, safety, and welfare, Low as well as global, cultural, social, environmental, and economic factors 3. An ability to communicate effectively with a range of audiences Medium 4. An ability to recognize ethical and professional responsibilities in engineering situations and make informed judgments, which must consider the impact Low of engineering solutions in global, economic, environmental, and societal contexts 5. An ability to function effectively on a team whose members together provide leadership, create a collaborative and inclusive environment, Low establish goals, plan tasks, and meet objectives

6. An ability to develop and conduct appropriate experimentation, analyze Low and interpret data, and use engineering judgment to draw conclusions 7. An ability to acquire and apply new knowledge as needed, using appropriate learning strategies High

COURSE OBJECTIVES

• Characterize and understand the key properties of the motion of a spacecraft in orbit under central body gravitation. • Design basic impulsive in-plane and out-of-plane maneuvers to transfer a spacecraft between two orbits. • Perform preliminary analysis for space missions including missions where a spacecraft is transferred between two bodies. • Understand the motion of a spacecraft under the influence of non-central gravity perturbations.

IMPORTANT NOTE

I consider it an honor and a privilege to be able to teach all of you, and I intend to provide the best instruction possible in order to enable you to get help. Regardless of how busy I am with other things, I will do what I am able to make myself available.

APPROXIMATE SCHEDULE FOR MATERIAL

Topic **Material Covered** Schedule Particle Kinematics, Particle Kinetics, and Week 1 Review of Newtonian Dynamics Rigid Body Kinematics Weeks 2 and 3 Motion of a Spacecraft Under Formulation and Solution of Central Body Gravitation Two-Body Differential Equation The Orbit in Space Weeks 4 and 5 Classical Orbital Elements and Position and Velocity Eccentric Anomaly, True Anomaly, Weeks 6 and 7 The Orbit as a and Kepler's Equation **Function of Time** Week 8 Rocket Rocket Equation and Impulse Thrust Approximation **Dynamics** Hohmann Transfer, Bi-Elliptic Transfer, Weeks 9 through 11 In-Plane and Out-of-Plane Impulsive and Non-Impulsive Orbital Transfer Bi-Parabolic Transfer and Out of Plane Transfers

Weeks 12 through 14 Inter-Body Trajectories and Patched-Conics, Launch Windows, Mid-Course Corrections, and Planetary Fly-Bys Orbital Transfer Between Two Bodies

Note: if for some reason you are unable to make my office hours, you can always schedule an appointment at a time that is mutually agreeable to both you and I.

OFFICE HOURS

OFFICE HOURS

Name Times **Meeting Location and Contact** Evenings via Zoom: 7:30 PM Anil V. Rao Zoom: https://ufl.zoom.us/j/98247791909 (Instructor) As Needed anilvrao@ufl.edu Monday/Wednesday: 2:00 PM — 4:00 PM Reitz Union Food Court Anil V. Rao Tuesday/Thursday: 2:30 PM to 4:30 PM Next to Starbucks (Instructor) Katrina Winkler Office Hours Zoom: https://ufl.zoom.us/j/98247791909 TBD (Teaching Assistant) k.winkler@ufl.edu Wanjiku Kanjumba Office Hours Zoom: https://ufl.zoom.us/j/98247791909

TBD

kanjumba.w@ufl.edu

Date Due

19 September 2025

10 October 2025

PERSONAL HOURS I have found that often students want to talk with me about topics other than the course. Sometimes it is just to get career directions and advice, other times to find out about opportunities to work in my research group as an undergraduate or graduate student. Because

students would like to have conversations on such topics (and other topics), each week I will hold what I call "personal hours". If you are interested in just having a conversation with me that is not specific to the course material, please join me for personal hours. I will try to make these hours actual in person hours because I feel it is the best way to have non-technical conversations. As a result, I will hold personal hours in the Reitz Union food court. **Personal Office Hours Times Meeting Location**

Reitz Union Food Court Friday 2:00 PM to 4:00 PM (Next to Starbucks)

Note: I am happy to schedule other times for personal meetings about topics not related to the course. Please feel free to ask.

(Teaching Assistant)

TEXTBOOK 1. Bate, R. R., Mueller, D. D., and White, J. E., Fundamentals of Astrodynamics, Dover Publications, 1971. 2. MATLAB for Dummies, Second Edition, John Wiley & Sons, 2014.

COURSE NOTES

I have created a set of typeset notes for the course. These notes are continually being updated. The current version of the notes are available by clicking here.

PROGRAMMING LANGUAGE REQUIREMENTS All coding in this course will be done using MATLAB. It is REQUIRED that everyone have a legally obtained STUDENT VERSION of MATLAB for use with the course. Anyone using UF Apps (that is, the time delays and other

issues due to the UF network). It is required that anyone who wants help must have a legally obtained STUDENT license of MATLAB installed to their computer. **HOMEWORK ASSIGNMENTS**

The homework will consist of three major homework assignments and a final project. All assignments are due at 11:59 PM on the University of Florida E-learning website. The bonus assignments (STK Level 1 and STK Level 2 Certifications) can be completed by by clicking here. Assignment **Due Date** Assignment

Background Material

PROJECT SCHEDULE

29 August 2025

Date Assigned

12 September 2025

3 October 2025

26 - 29 September 2025

7 - 10 November 2025

6 @ 4 Points = 24 Points

4 @ 12 Points = 48 Points

3 @ 10 Points = 33 Points

5 Points

5 Points

80 to less than 85

Homework #1 12 September 2025 Chapter 1 Problems Homework #2 Chapter 2 Problems 3 October 2025 Homework #3 Chapter 3 Problems 31 October 2025 Homework #4 Chapter 5 Problems 14 November 2025 Homework #5 Chapter 6 Problems 3 December 2025 STK Level 1 Certification Bonus #1 3 December 2025 3 December 2025 Bonus #2 STK Level 2 Certification

Material Through HW #2

Take-Home Quiz #1

Take-Home Quiz #2

Homework #0

Project Contents Project #1 Material Through HW #1

Homework Assignments

Projects

Take-Home Quizzes

Bonus #1 (STK Level 1 Certification)

Bonus #2 (STK Level 2 Certification)

Project #2

course, you can ask me for help).

Grades in this course are determined using the following scale:

The grading scale posted above is not flexible.

Your academic advisor or Graduate Coordinator

Made in RapidWeaver

Project #3 Material Through HW #3 31 November 2025 7 November 2025 28 November 2025 7 December 2025 Project #4 Material Through HW #4 TAKE-HOME QUIZ SCHEDULE Take-Home Quiz Date Contents

Material Through HW #2

Material Through HW #3

Take-Home Quiz #3 Material Through HW #4 5 - 8 December 2025 PROJECT FORMAT The course will have four projects. Each project will be made available at 5:00 PM on a Friday and will be due the following Friday by noon. Late projects will not be accepted under any circumstances except the usual exceptions (illness or other emergency). Each project will require the use of MATLAB along with an understanding of the key concepts. Thus, it is extremely important that you understand the theory in addition to just being able to solve problems. Furthermore, the projects will require knowledge gained in the process of completing the homework assignments. Your grade on the projects will be reflected via any procrastination in completing homework assignments.

The course will have three take-home quizzes. Each quiz will be a problem that will have both a theory (derivation) component. The quizzes must be completed independently (but, of

TAKE-HOME QUIZ FORMAT

MAKE-UP POLICY Because all assignments in this course are not time limited (in the same manner as that a usual in-class exam), make-ups will be provided on a case-by-case basis. If you have an issue (illness, other urgent matter), please discuss it with me and we will work to find a fair and reasonable solution.

COURSE GRADING Point Value Item

Total 105 Points + 10 Points Bonus IMPORTANT NOTES: Of the four projects, the lowest score on the first three projects will be dropped, while Project #4 is required for everyone. Whichever score of the first three projects are 12, 10, and 8, then the score of 8 will be dropped and the score of 10 will be counted twice. Regardless, everyone is required to put forth a good faith effort on all four projects in accordance with the good faith effort on all four projects in accordance with the good faith effort policy shown below. Next, even though the total for all required assignments adds to 103, the grade is based on a score of 100 (that is, the grading is out of a total of 100).

Letter Grade Score Range 95 and Above 90 to less than 95 85 to less than 90

GRADING SCALE

75 to less than 80 70 to less than 75 C+ 65 to less than 70 60 to less than 65 C-55 to less than 60 D+50 to less than 55 45 to less than 50 Less Than 45

NOTES ON ASSIGNMENT OF FINAL LETTER GRADES

ACADEMIC POLICIES & RESOURCES

• Finally, it is noted that while your individual scores for assignments, exams, and quizzes will be posted on E-learning (Canvas), the Canvas portal may not accurately reflect a student's relative standing in the class. Regardless of the information that is seen in Canvas, computation of final grades will be based on the criteria set forth above and a student's grade will only be final when grades have been computed at the end of the semester. IMPORTANT NOTE: Any assignment either not submitted or not completed with a good faith effort (where the judgment of "good faith effort" rests wholly with me) will result in a full letter grade deduction in the course. For example, if the final score falls into the category of an "A-" and one homework or quiz is not submitted or is deemed to not have been performed with a good faith effort, the final grade will be a "B-". This policy is not flexible.

To support consistent and accessible communication of university-wide student resources; instructors must include this link to academic policies and campus resources: https://go.ufl.edu/syllabuspolicies. Instructor-specific guidelines for courses must accommodate these policies. Commitment to a Positive Learning Environment

• HWCOE Human Resources, 352-392-0904, student-support-hr@eng.ufl.edu • Pam Dickrell, Associate Dean of Student Affairs, 352-392-2177, pld@ufl.edu

If you feel like your performance in class is being impacted by discrimination or harassment of any kind, please contact your instructor or any of the following:

• Any score on the boundary between two ranges will receive the higher grade (for example, a 94 receives a grade of "A-").

COMMITMENT TO A POSITIVE LEARNING ENVIRONMENT The Herbert Wertheim College of Engineering values varied perspectives and lived experiences within our community and is committed to supporting the University's core values. If you feel like your performance in class is being impacted by discrimination or harassment of any kind, please contact your instructor or

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any of the following: Your academic advisor or Graduate Coordinator • HWCOE Human Resources, 352-392-0904, student-support-hr@eng.ufl.edu

• Pam Dickrell, Associate Dean of Student Affairs, 352-392-2177, pld@ufl.edu

Students are expected to provide professional and respectful feedback on the quality of instruction in this course by completing course evaluations online via GatorEvals. Guidance on how to give feedback in a professional and respectful manner is available at https://gatorevals.aa.ufl.edu/students/. Students will be notified when the evaluation period opens, and can complete evaluations through the email they receive from GatorEvals, in their Canvas course menu under GatorEvals, in their Canvas course menu under GatorEvals, in their Canvas course menu under GatorEvals.aa.ufl.edu/public-

COURSE EVALUATIONS

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