



EAS4510 - Astrodynamics Fall 2021

COURSE INSTRUCTOR

Name: Dr. Anil V. Rao

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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

Name: Christian King

Contact: christianking@ufl.edu

Office Location: Available via Zoom

COURSE LOCATIONS AND CLASS PERIODS

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

Lecture Room: 310 Larsen Hall

Online Videos: Click [here](#) for Astrodynamics Playlist (On My YouTube Channel).

Office Hours Zoom Link:

- Meeting ID: [985 5871 4037](#)

- Click [here](https://ufl.zoom.us/j/96874723546) for Zoom link or copy and paste the following URL into your browser:
<https://ufl.zoom.us/j/96874723546>

CATALOG DESCRIPTION

Introduces the solar system. Includes study of two-body motion, Hohmann transfer, patched conics for interplanetary and lunar trajectories, 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

1. An ability to identify, formulate, and solve complex engineering problems 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, as well as global, cultural, social, environmental, and economic factors

3. An ability to communicate effectively with a

COVERAGE

High

Low

Medium

Low

range of audiences

4. An ability to recognize ethical and professional responsibilities in engineering situations and make informed judgments, which must consider the impact 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, establish goals, plan tasks, and meet objectives

6. An ability to develop and conduct appropriate experimentation, analyze 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

Low

Low

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 learn the material well. If you cannot make office hours, please contact me and we will set up a time for 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
Review of Newtonian Dynamics	Particle Kinematics, Particle Kinetics, and Rigid Body Kinematics	Week 1
Motion of a Spacecraft Under Central Body Gravitation	Formulation and Solution of Two-Body Differential Equation	Weeks 2 and 3
The Orbit in Space	Classical Orbital Elements and Position and Velocity	Weeks 4 and 5
The Orbit as a Function of Time	Eccentric Anomaly, True	Weeks 6 and 7

	Anomaly, and Kepler's Equation	Week 8
Rocket Dynamics	Rocket Equation	Weeks 9 through 11
In-Plane and Out-of-Plane Impulsive and Non-Impulsive Orbital Transfer	Hohmann, Bi-Elliptic, Bi-Parabolic, and Out-of-Plane Orbital Transfer	Weeks 12 through 14
Inter-Body Trajectories and Orbital Transfer Between Two Bodies	Patched-Conics, Launch Windows, Mid-Course Corrections, and Fly-Bys	

OFFICE HOURS

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		
Name	Times	Meeting Location and Contact
Anil V. Rao (Instructor)	Tuesday/Thursday 12:00 PM to 2:00 PM	Zoom: https://ufl.zoom.us/j/9687472 (Meeting ID: 985 5871 4037) anilvrao@ufl.edu
Christian King (Teaching Assistant)	Tuesday/Thursday 8:00 PM to 10:00 PM	

Zoom:

<https://ufl.zoom.us/j/9793831>
(Meeting ID: [979 3831 8652](#))
christianking@ufl.edu

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.

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 will not receive help during office hours or otherwise because of inefficiency of 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 5:00 PM on the due date and must be submitted through the Canvas course page on the University of Florida E-learning website.** The bonus assignments (STK Level 1 and STK Level 2 Certifications) can be completed by clicking [here](#).

Assignment	Assignment	Due Date
Homework #0	Background Material	30 Aug
Homework #1	Chapter 1 Problems	13 Sep
Homework #2	Chapter 2 Problems	4 Oct
Homework #3	Chapter 3 Problems	25 Oct
Homework #4	Chapter 5 Problems	8 Nov
Homework #5	Chapter 6 Problems	22 Nov
Bonus #1	STK Level 1 Certification	13 Dec
Bonus #2	STK Level 2 Certification	13 Dec

PROJECT SCHEDULE

Project	Contents	Date Assigned	Date Due
Project #1	Material Through HW #1	20 September 2020	27 September
Project #2	Material Through HW #2	11 October 2020	18 October
Project #3	Material Through HW #3	8 November 2020	15 November
Project #4	Material Through HW #4	29 November 2021	6 December

TAKE-HOME QUIZ SCHEDULE

Take-Home Quiz	Contents	
Take-Home Quiz #1	Material Through HW #2	8 – 11
Take-Home Quiz #2	Material Through HW #3	19 – 22
Take-Home Quiz #3	Material Through HW #4	10 – 13

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.

TAKE-HOME QUIZ FORMAT

The course will have three take-home quizzes. Each quiz will be a problem that will have both a theory (derivation) component along with a programming component. The quizzes will be significantly shorter than the projects, but will still require programming. The quizzes must be completed independently (but, of course, you can ask me for help).

ATTENDANCE RULES

Regular attendance is expected of all students on days when Zoom lectures are held. I will try to record the Zoom lectures, but please realize that recorded Zoom lectures are not necessarily the

easiest to follow.

CHEATING

Cheating of any kind in this course will be enforced in accordance with the university rules. Any violation of any kind (even something as simple as a single line of code that is identical in the homework of two students) will automatically result in an "E" in the course and will reported as appropriate to the Dean of Students Office.

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

Item	Point Value
Homework Assignments	6 @ 5 Points = 30 Points
Projects	4 @ 10 Points = 40 Points
Take-Home Quizzes	3 @ 10 Points = 30 Points
Bonus #1 (STK Level 1 Certification)	5 Points
Bonus #2 (STK Level 2 Certification)	5 Points
Total	100 Points + 10 Points Bonus

IMPORTANT NOTES: The unannounced in-class quizzes are purely for attendance purposes. As such, these in-class quizzes will not be graded (they are purely self-diagnostic so that each of you

can get a sense as to whether or not you understand a particular concept), but missing a quiz on account of an unexcused absence will result in a lowering of a student's final grade in the manner described above (that is, a deduction of one step for each missed quiz on account of an unexcused absence).

GRADING SCALE

Grades in this course are determined using the following scale:

Letter Grade	Score Range
A	95 and Above
A-	90 to less than 95
B+	85 to less than 90
B	80 to less than 85
B-	75 to less than 80
C+	70 to less than 75
C	65 to less than 70
C-	60 to less than 65
D+	55 to less than 60
D	50 to less than 55
D-	45 to less than 50
E	Less Than 45

NOTES ON ASSIGNMENT OF FINAL LETTER GRADES

- The grading scale posted above is not flexible.

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

STUDENTS REQUIRING ACCOMMODATIONS

Students with disabilities who experience learning barriers and would like to request academic accommodations should connect with the disability Resource Center by visiting <https://disability.ufl.edu/students/get-started/>. It is important for students to share their accommodation letter with their instructor and discuss their access needs, as early as possible in the semester.

COVID – 19

- You are expected to wear approved face coverings at all times during class and within buildings even if you are vaccinated.
- If you are sick, stay home and self-quarantine. Please visit the UF Health Screen, Test & Protect website about next steps, retake the questionnaire and schedule your test for no sooner than 24 hours after your symptoms began. Please call your primary care provider if you are ill and need immediate care or the UF Student Health Care Center at [352-392-1161](tel:352-392-1161) (or email covid@shcc.ufl.edu) to be evaluated for testing and to receive further instructions about returning to campus.
- If you are withheld from campus by the Department of Health through Screen, Test &

Protect, you are not permitted to use any on campus facilities. Students attempting to attend campus activities when withheld from campus will be referred to the Dean of Students Office.

- UF Health Screen, Test & Protect offers guidance when you are sick, have been exposed to someone who has tested positive or have tested positive yourself. Visit the UF Health Screen, Test & Protect website for more information.
- Please continue to follow healthy habits, including best practices like frequent hand washing. Following these practices is our responsibility as Gators.

COURSE EVALUATIONS

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, or via <https://ufl.bluera.com/ufl/>. Summaries of course evaluation results are available to students at <https://gatorevals.aa.ufl.edu/public-results/>.

IN-CLASS RECORDING

Students are allowed to record video or audio of class lectures. However, the purposes for which these recordings may be used are strictly controlled. The only allowable purposes are (1) for personal educational use, (2) in connection with a complaint to the university, or (3) as evidence in, or in preparation for, a criminal or civil proceeding. All other purposes are prohibited. Specifically, students may not publish recorded lectures without the written consent of the instructor.

A “class lecture” is an educational presentation intended to inform or teach enrolled students about a particular subject, including any instructor-led discussions that form part of the presentation, and delivered by any instructor hired or appointed by the University, or by a guest instructor, as part of a University of Florida course. A class lecture does not include lab sessions, student presentations, clinical presentations such as patient history, academic exercises involving solely student participation, assessments (quizzes, tests, exams), field trips, private conversations between

students in the class or between a student and the faculty or lecturer during a class session.

Publication without permission of the instructor is prohibited. To “publish” means to share, transmit, circulate, distribute, or provide access to a recording, regardless of format or medium, to another person (or persons), including but not limited to another student within the same class section. Additionally, a recording, or transcript of a recording, is considered published if it is posted on or uploaded to, in whole or in part, any media platform, including but not limited to social media, book, magazine, newspaper, leaflet, or third party note/tutoring services. A student who publishes a recording without written consent may be subject to a civil cause of action instituted by a person injured by the publication and/or discipline under UF Regulation 4.040 Student Honor Code and Student Conduct Code.