EAS4510 - Astrodynamics
Spring 2023

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/PEER MENTOR/SUPERVISED TEACHING ASSISTANT

(Please Contact Through Canvas Website)

Name: Katrina Winkler
Contact: Via Canvas Site
Office Location: Available via Zoom

COURSE LOCATIONS AND CLASS PERIODS

Class Period: MWF 10:40 - 11:30 AM (Period 4). Attendance is expected and will be taken at random
Lecture Room: Florida Gym 220
Online Videos: Click here for Astrodynamics Playlist (On My YouTube Channel)
Office Hours Zoom Link:

- Meeting ID: 977 0037 4923
- Click here for Zoom link or copy and paste the following URL into your browser: https://ufl.zoom.us/j/97700374923

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	COVERAGE
1. An ability to identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics	High
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	Low
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 of engineering solutions in global, economic, environmental, and societal contexts	Low
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	Low
6. An ability to develop and conduct appropriate experimentation, analyze and interpret data, and use engineering judgment to	High

draw conclusions

7. An ability to acquire and apply new knowledge as needed, using appropriate learning strategies

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
HighHighHighHighHighHigh 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 Anomaly, and Kepler's Equation	Weeks 6 and 7
Rocket Dynamics	Rocket Equation and Impulse Thrust Approximation	Week 8
In-Plane and Out-of-Plane Impulsive and Non-Impulsive Orbital Transfer	Hohmann Transfer, Bi-Elliptic Transfer, Bi-Parabolic Transfer and Out of Plane Transfers	Weeks 9 through 11
Inter-Body Trajectories and Orbital Transfer Between Two Bodies	Patched-Conics, Launch Windows, Mid-Course Corrections, and Planetary Fly-Bys	Weeks 12 through 14

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)	Mon/Tues/Thurs 2:00 PM to 3:30 PM or By Appointment	Zoom: https://ufl.zoom.us/j/94358327607 anilvrao@ufl.edu
Bradley Loss (Teaching Assistant)	Wednesday 2:00 PM to 3:30 PM	Zoom: https://ufl.zoom.us/j/9103306509 b.loss@ufl.edu

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
Friday 2:00 PM to 4:00 PM	Reitz Union Food Court (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.

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 11:59 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 by clicking here.

Assignment	Assignment	Due D
Homework #0	Background Material	**16 Januar**
Homework #1	Chapter 1 Problems	**30 Januar**
Homework #2	Chapter 2 Problems	**20 Februa**
Homework #3	Chapter 3 Problems	**10 Marc**
Homework #4	Chapter 5 Problems	**10 April**
Homework #5	Chapter 6 Problems	**1 May**
Bonus #1	STK Level 1 Certification	**1 May**
Bonus #2	STK Level 2 Certification	**1 May**

PROJECT SCHEDULE

Project		Contents		Date Assigned		Date Due
Project #1		Material Through HW #1		**14 September 2021**		**6 February**
Project #2		Material Through HW #2		**12 October 2022**		**27 February**
Project #3		Material Through HW #3		**9 November 2022**		**27 March 2**
Project #4		Material Through HW #4		**5 December 2022**		**17 April 20**

TAKE-HOME QUIZ SCHEDULE

Take-Home Quiz	Contents	Date
Take-Home Quiz #1	Material Through HW #2	**11 — 14 Oct**
Take-Home Quiz #2	Material Through HW #3	**15 — 18 Nove**
Take-Home Quiz #3	Material Through HW #4	**6 — 9 Decem**

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

- 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 (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.

UNIVERSITY HONESTY POLICY

UF students are bound by The Honor Pledge which states, "We, the members of the University of Florida community, pledge to hold ourselves and our peers to the highest standards of honor and integrity by abiding by the Honor Code. On all work submitted for credit by students at the University of Florida, the following pledge is either required or implied: "On my honor, I have neither given nor received unauthorized aid in doing this assignment." The Honor Code (https://sccr.dso.ufl.edu/process/student-conduct-code/) specifies a number of behaviors that are in violation of this code and the possible sanctions. Furthermore, you are obligated to report any condition that facilitates academic misconduct to appropriate personnel. If you have any questions or concerns, please consult with the instructor or TAs in this class.

COMMITMENT TO A SAFE AND INCLUSIVE LEARNING ENVIRONMENT

The Herbert Wertheim College of Engineering values broad diversity within our community and is committed to individual and group empowerment, inclusion, and the elimination of discrimination. It is expected that every person in this class will treat one another with dignity and respect regardless of gender, sexuality, disability, age, socioeconomic status, ethnicity, race, and culture.

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:

- Your academic advisor or Graduate Program Coordinator
- Jennifer Nappo, Director of Human Resources, 352-392-0904, jpennacc@ufl.edu
- Curtis Taylor, Associate Dean of Student Affairs, 352-392-2177, taylor@eng.ufl.edu
- Toshikazu Nishida, Associate Dean of Academic Affairs, 352-392-0943, nishida@eng.ufl.edu

SOFTWARE USE

All faculty, staff, and students of the University are required and expected to obey the laws and legal agreements governing software use. Failure to do so can lead to monetary damages and/or criminal penalties for the individual violator. Because such violations are also against University policies and rules, disciplinary action will be taken as appropriate. We, the members of the University of Florida community, pledge to uphold ourselves and our peers to the highest standards of honesty and integrity.

STUDENT PRIVACY

There are federal laws protecting your privacy with regards to grades earned in courses and on individual assignments. For more information, please see: https://registrar.ufl.edu/ferpa.html

CAMPUS RESOURCES

HEALTH AND WELLNESS

U Matter, We Care: Your well-being is important to the University of Florida. The U Matter, We Care initiative is committed to creating a culture of care on our campus by encouraging members of our community to look out for one another and to reach out for help if a member of our community is in need. If you or a friend is in distress, please contact umatter@ufl.edu so that the U Matter, We Care Team can reach out to the student in distress. A nighttime and weekend crisis counselor is available by phone at 352-392-1575. The U Matter, We Care Team can help connect students to the many other helping resources available including, but not limited to, Victim Advocates, Housing staff, and the Counseling and Wellness Center. Please remember that asking for help is a sign of strength. In case of emergency, call 9-1-1.

Counseling and Wellness Center: https://counseling.ufl.edu, and 392-1575; and the University Police Department: 392-1111 or 9-1-1 for emergencies.

Sexual Discrimination, Harassment, Assault, or Violence: If you or a friend has been subjected to sexual discrimination, sexual harassment, sexual assault, or violence contact the Office of Title IX Compliance, located at Yon Hall Room 427, 1908 Stadium Road, (352) 273-1094, title-ix@ufl.edu

Sexual Assault Recovery Services (SARS): Student Health Care Center, 392-1161.

University Police Department: 392-1111 (or 9-1-1 for emergencies), or http://www.police.ufl.edu/.

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