Engineering Mechanics – Self Driving Satellites

EAS 6939 Class 24849
Class Periods: T period 4, 10:40AM – 11:30AM, Th period 4-5, 10:40-12:35 AND EDGE
Location: NEB 100
Academic Term: Spring 2026

Instructor:
Dr. Christopher "Chrispy" Petersen
c.petersen1@ufl.edu
Office Hours: NEB453, We 1:00 pm - 2:00 pm, Fr 2:00 pm-3:00 pm or by appointment

Teaching Assistant/Peer Mentor/Supervised Teaching Student:
None

Course Description
This class looks at technology and methods to make satellites self-driving, e.g. techniques that, in real-time, allow a spacecraft to perform their mission. This class will blend theory and application to explore how guidance, navigation, control, and autonomy can be designed, developed, and deployed for spacecraft systems.

Course Pre-Requisites / Co-Requisites
None.

Course Objectives
To improve knowledge of techniques learned in theory and understand implementation/computation limitations of said techniques. The overall aspects that the course will teach will be in
- *Spacecraft dynamics (e.g. how do satellites move about one another)*
- *Spacecraft navigation (e.g. estimate what orbit I am in given sensor data)*
- *Spacecraft control (e.g. what thrusters to use)*
- *Spacecraft guidance (e.g. go from orbit to orbit)*
- *Spacecraft automation (e.g. fault detection and correction systems)*
- *Spacecraft Command & Data Handling, CD&H (e.g. how do I pass and store data)*
- *Real-time algorithms (e.g. how do I write code from theory to work in a system)*
- *Algorithm optimization (e.g. how do I make an algorithm run faster/use less CPU)*

The course has the dual objectives of teaching the theory of why techniques work and the added aspects on how they are implemented.

Materials and Supply Fees
None

Required Textbooks and Software
- A computer that enables c++ programming. For windows, it is recommended to download Windows Visual Studio or use the Ubuntu app for this. Apple/Linux should be equipped for c++ programming, and use of an Interface Development Environment for coding is up to the student. The instructor will teach using "VIM" in the terminal, but will not restrict it.   Other ways (e.g. Putty for Windows) can also facilitate.
- To process the results, MATLAB/Simulink, at least version 2018a, base version may be used (no external toolboxes required). UF Apps can be used as well

Recommended Materials
- For coding: Look at Stack Overflow or Google!
- General all round book: Spacecraft Orbit: Models, Methods, and Applications. Montebruck et al. Springer 2000.

- If basic astrodynamics/control is needed see: Spacecraft Dynamics and Control: An Introduction. A Ruiter et al. Wiley, 2013
- If basic estimation is needed, see: Statistical Orbit Determination, Schutz et al. Elsevier, 2004
- If basic dynamics knowledge is needed, see: Dynamics of Particles and Rigid Bodies: A Systematic Approach, A. Rao, Cambridge University Press, 2006.

Course Schedule
Tentative, may adjusted as the semester progresses.
Week 1-3:   Spacecraft dynamics and communication
Week 4-6:   Spacecraft navigation
Week 7-8:   Spacecraft control
Week 8-9 ish: Midterm
Week 10-12:   Spacecraft guidance
Week 13-15:   Spacecraft Autonomy and System Interactions
Week 16:   Final dd

Course Specifics
The class every week will have three parts. The first section (Tuesday) will be a traditional blackboard lecture where fundamentals are taught and discussed. The second section (Thursday) the first half will be in-lecture applications to solidify these concepts with discussion and in-class participation. The second half will have a computer component to show the application of the material and enable frequent discussions. In class, students will be expected to participate via in-class "quizzes". These will not always be necessarily marked for correctness, but rather effort. Throughout the week there may be pre-recorded lectures for students to watch to expedite the learning process and save time in class. All-in-all, this type of class is created to facilitate a blend of theory and application. The structure may evolve through the semester due to pacing and remaining on schedule.

Outside of class, most weeks there will be quizzes in three portions. These quizzes are intended to reinforce knowledge and understand gaps. The first part of the quiz is approx. 6 multiple choice questions, and this part can be taken as many times as possible during a one week period. However, each attempt at a SINGLE question will lower the worth of that question by 2%-10%. The minimum lower score for that portion will be 80%, however, this minimum score is only guaranteed if at every retry the student in the comment portion of the quiz explains why they got the question wrong in the first place and why they chose their current answer. If this is not sufficient, then the instructor may deduct further to lower the score below 80%. The second portion will be 2-3 written questions graded once, and will be assessed on technical thought. Remember, more writing does not equal better. The third will be a video upload of the student in front of one slide discussing a topic of the week. The video <1 min for technical discussion then 30 seconds are allowed for questions. The instructor will provide video feedback back on this. The quizzes are not intended to be difficult or take too much time, but to ensure concepts are not forgotten between assignments.

Assignments will have 4 parts to them; (1) Theory, (2) Coding, (3) Explanation, and (4) Research Paper. The material here reflects the last 2-3 weeks plus the quizzes preceding up to it, resulting in the creation and validation of methods that can be implemented on satellites.

The theory portion is to serve as the way students can dive deeper into aspects we did not have time to investigate. Students need to show all their work for full credit. Partial credit will be given to students who show their process. If a student cannot arrive at the answer, highlighting that the answer is incorrect with an explanation of why may also result in partial credit. Recognizing something is wrong is sometimes just as important as getting something right. Please ensure that the assignments are **legible**, as points are difficult to give if the process cannot be followed. All answers will be filled out on a template and be boxed on written work. The primary form of submission will be through Canvas, but if not possible, other acceptable forms of submission will be used as approved by the university.

For the coding portions, in which case the student is expected to adequately comment their code for readability. All resources along with extra videos will be given so that students can perform the assignments with the base software required (e.g. there should not require any toolboxes). Students will be graded on how the code functions. To do so, a framework may be given by the instructor to ensure the code can be graded. If the code does not produce answers that the student believes is correct, or if the code will not run, the student should comment on why they believe it is not working and point to the source, in which case partial credit maybe given. Recognizing something is wrong is sometimes just as important as getting something right.

For the Explanation portion, the professor will pair up two students together, and all three will meet at an agreed time for 4-5 min. The professor will give four topics ahead of time, and one student will choose a single topic to explain to the professor and the other student for 1 minute. Then the professor and/or student will ask a question to be answered in 1 minute. Then the other student will have a turn. This is intended to enforce scientific articulation, as reinforcing concepts is at its greatest when having to articulate them.

For the written portion, the students will be gradually building up their project of a research paper via the homework. The students will be graded not only on technical content, but also scientific articulation. Students may be asked to also provide critical feedback on other students paper, in order to learn how to provide good commentary.

After an assignment is graded, students will be given a score with a brief generated report that shows how the student did and maybe how to improve. The students will then have approx.. two weeks to "redo" their assessments to make up to half credit back. To get the full half credit, students must point out where they messed up and why they did it that way. Then students must fix the problem and demonstrate they understand why this is the correct method. Student should not simply do the problem over with solutions. Written feedback is important, and if discuss is not given sufficiently, less than half credit will be given. Please note, because the instructor gives up to half credit back on homework assignments, **he will not accept late assignments at a reduced grade**. Students should pass in what they have at the due date, and can recover up to half points later. At the end of the semester, the instructor will offer up to 1/4 to 1/3 points back for redos in preparation for their final.

At the end of the semester, there will be a final project, consisting of a written and an oral presentation. The written part will be built up throughout the semester. The oral presentation will consist of a 3-5 min, single chart presentation in front of the class. This will be during the end of the semester, when there are no assignments due.

There will be one midterm and one final, both are open book, open note, open laptop. The midterm will consist of two parts. The first will be an in person exam, where students will be given a problem, like the assignments, to solve half-way. This will be passed in at the end of class to grade. Then the students will be given at least 48 hours to complete the take-home portion, where they will continue the problem. The in-person portion focuses on set-up and mathematics, while the take home focuses on results and coding. All students must show be in attendance for the exam. The final will be in person during finals week. This will not be shifted.

The class implements a "Comment Card" system. At the end of every lecture each student will be either given a piece of paper or a weblink to use that will enable writing/drawing anything: a comment, a question for the class, a critique for the instructor, a joke, a drawing, a topic of discussion, anything. These are completely anonymous and no name should be given. Then at the beginning of the next class, 10-20 will be chosen at random to read in-front of the class (though all cards will be reviewed beforehand to ensure all voices heard). Please be respectful in the Comment Card system, as any inappropriate Comment Cards will be removed from the random reading process.

Attendance Policy, Class Expectations, and Make-Up Policy
Regular lectures will be held in person and thus attendance will be expected for on-campus students while for EDGE regular watching of videos when they come out. Attendance will not be tracked explicitly. Instead attendance will be tracked implicitly via frequent in-lecture quizzes that happen every lecture for on-campus students, and via quizzes for EDGE students. At the end of the semester, the participation credit will be a function of (a) how many in-lecture quizzes students do and (b) correct answers if you are an EDGE student (or in the case that on-campus is graded). Lecture material will be made available to all students throughout on CANVAS, but note this does not mean

you will have the instructor version of the notes. It is up to you to go through the EDGE videos to make it up. Your instructor is also available to assist to ensure students can catch-up.

If a student is going to be absent for any reason, please submit a form using the Microsoft Forms link to request that absence. If there is sufficient time before the absence (e.g. >2 days for assignments, >3 days for exams), the student and the instructor should come to an agreement beforehand on how the student will make-up their course material. Note absences are not guaranteed to be accepted, they must be reasonable. If an absence is sudden (e.g. <2 days for assignments, <3 days for exams), then letting the instructor know after the missed class will be acceptable if a message is sent as soon as possible after the absence. Once returned to campus, the student and instructor will work on a plan to make-up the material. Please note reasons for absence are noted in the university attendance-polices (see link below). As this is a graduate class, note that conference travel may be acceptable, but not for the entire conference if it is too long (this must be discussed with the professor), Please do not force one-self to come to campus for lecture, if there is a reason please let the instructor know. Requirements for class attendance and make-up exams, assignments, and other work in this course are consistent with university policies. Click here to read the university attendance policies:
https://catalog.ufl.edu/UGRD/academic-regulations/attendance-policies/

Evaluation of Grades
Please note: the total grade gives 105%. **This is not by mistake** . Students have essentially 5 extra points to act as buffer if a score in another column is lower than expected.

Assignment	Total Points	Percentage of Final Grade
Assignments (5)	100 each	40%
Participation via In-Class Quizzes	100 each	12%
Out of Class Quizzes	100 each	12%
Project	100 Points	10%
Midterm Exam	100	13%
Final Exam	100	13%
		100%

Grading Policy
The following is given as an example only.

Percent	Grade	Grade Points
93.4 - 100	A	4.00
90.0 - 93.3	A-	3.67
86.7 - 89.9	B+	3.33
83.4 - 86.6	B	3.00
80.0 - 83.3	B-	2.67
76.7 - 79.9	C+	2.33
73.4 - 76.6	C	2.00
70.0 - 73.3	C-	1.67
66.7 - 69.9	D+	1.33
63.4 - 66.6	D	1.00
60.0 - 63.3	D-	0.67
0 - 59.9	E	0.00

More information on UF grading policy may be found at:
https://catalog.ufl.edu/ugrad/current/regulations/info/grades.aspx

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.

Course Evaluation
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 at 392-1111 (or 9-1-1 for emergencies), or http://www.police.ufl.edu/.

Academic Resources

E-learning technical support, 352-392-4357 (select option 2) or e-mail to Learning-support@ufl.edu. https://lss.at.ufl.edu/help.shtml.

Career Connections Center, Reitz Union, 392-1601. Career assistance and counseling; https://career.ufl.edu.

Library Support, http://cms.uflib.ufl.edu/ask. Various ways to receive assistance with respect to using the libraries or finding resources.

Teaching Center, Broward Hall, 392-2010 or 392-6420. General study skills and tutoring. https://teachingcenter.ufl.edu/.

Writing Studio, 302 Tigert Hall, 846-1138. Help brainstorming, formatting, and writing papers. https://writing.ufl.edu/writing-studio/.

Student Complaints Campus*:* https://sccr.dso.ufl.edu/policies/student-honor-code-student-conduct-code/;https://care.dso.ufl.edu.

On-Line Students Complaints*: https://distance.ufl.edu/state-authorization-status/#student-complaint*.

AI Guidelines:

AI is consistently becoming more relevant in the world. In general, this class subscribes to the following policy:
- Some AI: Generative AI tools may be used to enhance some assignments in this course. Assignment instructions will differentiate between distinct human and AI tasks. Any work that is done using generative AI must be cited in your submission.

PLEASE NOTE: AI may never, under any circumstances, be used to do a majority of your work. If you are caught, then that will result in a zero for that work and further consequences will be discussed. That said, AI can be used as a tool. For you to be accepted as use of AI, please print out the complete chat you used for you work, and then summarize how you used the tool. Grading will be scaled appropriately. Please note AI will not be used for some portions of this class, in which cases that will be explicitly mentioned.

In general this class contains writing portions. Under no circumstances should these be the work of AI. Please write your own thoughts. Consequences still apply from above.