AERO 3240
Orbital Mechanics

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Course Outline

About the Author

Steve Ulrich is an Associate Professor at Carleton University. He earned his B.Eng. and M.A.Sc. in electrical engineering from the Université de Sherbrooke, and his Ph.D. in aerospace engineering from Carleton University. From 2006 to 2008, he was Spacecraft GN&C Research Engineer at NGC Aerospace Ltd., and in 2013 he was Postdoctoral Associate at the MIT Space Systems Laboratory. He is a member of the AIAA Guidance, Navigation and Control Technical Committee and an Associate Editor for The Journal of the Astronautical Sciences.

Prerequisites

MAAE 2101 Engineering Dynamics
Familiarity with MATLAB/Simulink (or another mathematical programming language) is an asset.

Contact Information

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Topics

Chapter 1 - Translational Kinematics and Dynamics
Chapter 2 - Two-Body Problem
Chapter 3 - Orbital Perturbations
Chapter 4 - Orbital Maneuvers
Chapter 5 - Spacecraft Formation Flying
Appendix A - Introduction to Modern State-Space Control
Bibliography

There is no required textbook, as these lecture notes will be the primary material. Some useful textbooks upon which the notes were developed include:


Additionally, the following journal articles were also useful in preparing the material on spacecraft formation flying:

Course Organization

Lectures

This course will be delivered in a blended fashion. Lectures will be delivered asynchronously. Students will then access material via cuLearn and complete activities on their own time. Students will need to be available during the lecture meeting time for the midterm only.

Tutorials (Monday, 11:35 am - 12:25 pm, Online or MC 2000)

There is one 50-minute tutorial period per week. During this tutorial, students will either: 1) work on their own, through problems related to the lecture material covered previously or 2) join Prof. Ulrich for an in-person Q&A session (or the TA for an online session). It is expected that students will also work through these problems outside the tutorial periods. These problems can be found in the course notes, at the end of each chapter. It is important to note that these problems also serve as a mean to introduce new concepts and to expand on the ones covered during the lectures, and as such they must be treated as an integral part of the course material.

Online Resources

Course information, lecture notes, lecture videos and MATLAB/Simulink resources will be posted on cuLearn.

Evaluation

Grading

Assignment: 30%
Midterm Exam: 30%
Final Exam: 40%
STK Certification: 5% (bonus)

Assignment

Due on December 10, 2021, the assignment consists in a written document reporting the results of all problems requiring the use of MATLAB/Simulink. In the lecture notes, these specific problems are indicated with a * next to the problem number. All MATLAB files and Simulink diagrams must also be provided in the report, as an appendix.

Examinations

Midterm Exam: closed-book, with 1 hand-written double-sided cheat sheet, held on November 1, 2021 (80 min). The exam questions will be posted online on November 1, at 4:05 pm and the answers will have to be submitted by 5:25 pm on the same day.

Final Exam: closed-book, with 2 hand-written double-sided cheat sheets, held during the examination period at the end of term (3 hours)
Academic Accommodation

You may need special arrangements to meet your academic obligations during the term. For an accommodation request the processes are as follows:

Pregnancy obligation

Write to me with any requests for academic accommodation during the first two weeks of class, or as soon as possible after the need for accommodation is known to exist. For more details visit the Equity Services website http://www.carleton.ca/equity/

Religious obligations

Write to me with any requests for academic accommodation during the first two weeks of class, or as soon as possible after the need for accommodation is known to exist. For more details visit the Equity Services website http://www.carleton.ca/equity/

Academic accommodations for students with disabilities

The Paul Menton Centre for Students with Disabilities (PMC) provides services to students with Learning Disabilities (LD), psychiatric/mental health disabilities, Attention Deficit Hyperactivity Disorder (ADHD), Autism Spectrum Disorders (ASD), chronic medical conditions, and impairments in mobility, hearing, and vision. If you have a disability requiring academic accommodations in this course, please contact PMC at 613-520-6608 or pmc@carleton.ca for a formal evaluation. If you are already registered with the PMC, contact your PMC coordinator to send me your Letter of Accommodation at the beginning of the term, and no later than two weeks before the first in-class scheduled test or exam requiring accommodation (if applicable). Requests made within two weeks will be reviewed on a case-by-case basis. After requesting accommodation from PMC, meet with me to ensure accommodation arrangements are made. Please consult the PMC website at www.carleton.ca/PMC for the deadline to request accommodations for the formally-scheduled exam (if applicable).

You can visit the Equity Services website to view the policies and to obtain more detailed information on academic accommodations at http://www.carleton.ca/equity/

Special Information for Pandemic Measures

All members of the Carleton community are required to follow COVID-19 prevention measures and all mandatory public health requirements (e.g. wearing a mask, physical distancing, hand hygiene, respiratory and cough etiquette) and the mandatory self-screening at https://carleton.ca/covid19/screening/ prior to coming to campus daily.

If you feel ill or exhibit COVID-19 symptoms while on campus or in class, please leave campus immediately, self-isolate, and complete the mandatory symptom reporting tool at carleton.ca/covid19/covid-19-symptom-reporting/. For purposes of contact tracing, attendance will be taken in all classes and labs. Participants can check in using posted QR codes through the cuScreen platform where provided. Students who do not have a smartphone will be required to complete a paper process as indicated on the COVID-19 website https://carleton.ca/covid19/.
All members of the Carleton community are required to follow guidelines regarding safe movement and seating on campus (e.g. directional arrows, designated entrances and exits, designated seats that maintain physical distancing). In order to avoid congestion, allow all previous occupants to fully vacate a classroom before entering. No food or drinks are permitted in any classrooms or labs.

For the most recent information about Carleton’s COVID-19 response and required measures, please see the University’s COVID-19 webpage here https://carleton.ca/covid19/ and review the Frequently Asked Questions (FAQs) at https://carleton.ca/covid19/faq/. Should you have additional questions after reviewing, please contact covidinfo@carleton.ca

Please note that failure to comply with University policies and mandatory public health requirements, and endangering the safety of others are considered misconduct under the Student Rights and Responsibilities Policy available at https://carleton.ca/studentaffairs/student-rights-and-responsibilities/. Failure to comply with Carleton’s COVID-19 procedures may lead to supplementary action involving Campus Safety and/or Student Affairs.

Copyright

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Note that some students may wish to create their own audio or video recording of a lecture as a personal study aid. As there is no Carleton policy on this matter, whether instructors wish to record their lectures or have their lectures recorded or not is entirely at the discretion of the individual instructor. It is important to know, as note above, that a lecture is considered the intellectual property of the instructor. Furthermore, video recording of a lecture would also require the express written permission of other students whose presence or statements might also be recorded. In addition, audio and/or video recording may also lead to several problematic cases of students creating recordings of lectures and subsequently sharing these recordings with other students, sometimes on publicly accessible websites, and occasionally for profit. In this context, students may not create audio or video recordings of lectures with the exception of those students requiring an accommodation for a disability, who are referred to the Paul Menton Centre as they may be able to provide other strategies and/or authenticate the request.

To summarize, students creating unauthorized audio and/or video recording of lectures, and/or reproducing or redistributing without prior written consent of the instructor violate the instructor’s intellectual property rights and the Canadian Copyright Act.