AA279C: Spacecraft Attitude Determination and Control

Zac Manchester

Spring 2018

Course Description

This course is all about attitude: pointing, slewing, spinning, and (hopefully not) tumbling. We will discuss:

- Attitude representations and how to effectively parameterize attitude in different situations.
- How to model and simulate spacecraft attitude dynamics.
- How to estimate attitude from sensor measurements.
- How to manage a spacecraft's attitude both with passive physics and closed-loop control.

The course will be based around a project in which each student analyzes the attitude determination and control system (ADCS) for a spacecraft mission.

Instructor

Prof. Zac Manchester **Email:** zacmanchester@stanford.edu **Office:** Durand 267

Logistics

- Lectures will be 3:00 to 4:20 Monday, Wednesday, and Friday in McCullough 126.
- Office hours will be held Tuesdays and Wednesdays 11:00 to 12:00 in Durand 267.
- Homework assignments will be due by 5:00 pm on Wednesdays.
- Canvas will be used to distribute course materials and collect assignments.

Assignments and Exams

Each week students will be asked to analyze some aspect of the ADCS design for their chosen spacecraft. A write-up of this analysis will be reviewed by the instructor and feedback will be returned to students the following week. At the end of the quarter, these weekly assignments will be compiled into a final report. There will be no exams in this course.

Grading

Grading will be based on:

- 40% class participation and punctuality with homework assignments
- 60% Completeness, consistency, and quality of the class project

Stanford's grading system is defined by the Faculty Senate as A=Excellent, B=Good, C=Satisfactory, D=Minimal Pass, and NP=Not Passed.

Reference Books

We'll mainly refer to two books during the course:

1. P. Hughes, *Spacecraft Attitude Dynamics*, Dover, 2004.
2. F. Markley and J. Crassidis, *Fundamentals of Spacecraft Attitude Determination and Control*, Springer, 2014.

The Hughes book is available in paperback for around $12, so I would recommend buying it. Markley and Crassidis costs about $75 for a hardback, or you can download the PDF for free through the library website. There is one more reference you should at least be aware of and may want to consult (but it is not required):

3. J. Wertz, *Spacecraft Attitude Determination and Control*, Kluwer, 1978.

Schedule of Topics

Week 1: Attitude parameterization and the SO(3) group

Week 2: Rigid-body and gyrostat dynamics

Week 3: Damping and environmental perturbations

Week 4: Spinning spacecraft and stability

Week 5: Attitude determination: sensor measurements and TRIAD

Week 6: Attitude determination: Whaba's problem

Week 7: Attitude determination: Kalman filters

Week 8: Attitude control: passive solutions

Week 9: Attitude control: feedback control

Week 10: Advanced topics