

Statistical Orbit Determination: ASEN 5070

Fall, 2012

Jeffrey S. Parker, George H. Born

TAs:

Eduardo Villalba, Paul Anderson

Course Syllabus

Instructor: Dr. Jeffrey S. Parker
ECNT 418, Phone: (303) 931-5334
parkerjs@colorado.edu

Dr. George H. Born
ECNT 316, Phone: (303) 492-8638
george.born@colorado.edu

Teaching Assistants:

Eduardo Villalba
ECNT 414
eduardo.villalba@colorado.edu

Paul Anderson
ECEE 275
paul.anderson@colorado.edu

Lectures: TR 3:30 – 4:15pm, ECEE 283

Office Hours:

M 10:00 am – 11:00 am	(Paul's office: ECEE 275)
M 2:00 pm – 3:00 pm	(Jeff's office: ECNT 418)
T 1:00 pm – 2:00 pm	(Eduardo's office: ECNT 414)
W 10:00 am – 11:00 am	(Jeff's office: ECNT 418)
W 2:00 pm – 3:00 pm	(George's office: ECNT 316)
Or by appointment	

Text: Tapley, B.D., Schutz, B.E., and Born, G.H., Statistical Orbit Determination, Elsevier Academic Press, New York, 2004.

Course Web Page: D2L: learn.colorado.edu and
ccar.colorado.edu/CCAR/ASEN5070/

Overview: This course provides the tools needed to perform “Stat OD”, namely the process by which we use many observations of a satellite in order to

determine the best estimate and corresponding uncertainty of the state of a satellite. The course derives all equations needed for several filtering techniques. The course project simulates the navigation of an operational satellite in low Earth orbit.

Homework Policy: Each homework assignment is given out on a Tuesday and due 9 days later, on a Thursday. Unless otherwise noted, the homework will be submitted electronically as a PDF file to the Desire2Learn (D2L) dropbox. It is suggested that the homework be written in LaTeX (pdflatex specifically) or Word. If using Word, be sure to save the final document as a PDF file. See an instructor or TA for questions concerning LaTeX. If you have any questions or concerns about homework grading, you need to see an instructor within 2 weeks of having the homework returned to you.

Computer Programming: This course involves significant computer programming. Any programming language is acceptable. The instructors and TAs will assist with any MATLAB questions. Jeff will assist with any Python questions and simple C/C++ questions. No other support is available. We will only assist debugging your software during office hours in person. You will be required to submit your code from time to time along with an assignment.

Concept Quizzes: There will be a concept quiz on the D2L website that each student must take prior to each lecture (unless otherwise noted). The quiz will become available at midnight before the class and the quiz will be due at 1:00 pm the day of the lecture. These are short and will be used to judge which material to present during the lecture.

Exams: There will be two mid-term exams and a third take-home exam. Each will cover approximately a third of the course material, each building on the previous. If you have any questions or concerns about exam grading, you need to see an instructor within 2 weeks of having the exam returned to you.

Class/Exam Attendance: You are expected to attend class and the exams. If you need to miss a lecture, it is your responsibility to catch up on the material, via CAETE videos and the material from the textbook. Campus policy regarding religious observances requires that faculty make every effort to reasonably and fairly deal with all students who, because of religious obligations, have conflicts with scheduled exams, assignments or required attendance. If you cannot attend a regularly scheduled class, it is up to the student to catch up on the missed material. If you cannot take an exam on a particular day, please let the instructor know at the time the exam is being scheduled.

Grading Policy: Each homework will be weighted equally. Each exam will be

weighted the same. The concept quizzes will be graded leniently: if you attempt it you will automatically earn 50% of the quiz points; any correct answers add to the score, capped at 100%.

Homework = 20%
Quizzes/Exams = 50%
Course Project = 30%

Honor Code: All students of the University of Colorado at Boulder are responsible for knowing and adhering to the academic integrity policy of this institution. Violations of this policy may include: cheating, plagiarism, aid of academic dishonesty, fabrication, lying, bribery, and threatening behavior. All incidents of academic misconduct shall be reported to the Honor Code Council (honor@colorado.edu; 303-735-2273). Students who are found to be in violation of the academic integrity policy will be subject to both academic sanctions from the faculty member and non-academic sanctions (including but not limited to university probation, suspension, or expulsion). Other information on the Honor Code can be found at <http://www.colorado.edu/policies/honor.html>

As of the fall of 2010, all ASEN students are required to signed an acknowledge form of the honor code which is available at <http://www.colorado.edu/aerospace/HonorCode.html>

Bottom line: you represent the University of Colorado and we expect all graduates to maintain integrity in the workforce. This course teaches you how to navigate satellites. Any errors may result in the loss of a multi-million dollar vehicle and/or loss of life! Please keep this in mind at all times.

Students with Disabilities: If you qualify for accommodations because of a disability, please submit to your professor a letter from Disability Services in a timely manner (for exam accommodations provide your letter at least one week prior to the exam) so that your needs can be addressed. Disability Services determines accommodations based on documented disabilities. Contact Disability Services at 303-492-8671 or by e-mail at dsinfo@colorado.edu.

If you have a temporary medical condition or injury, see Temporary Medical Conditions: Injuries, Surgeries, and Illnesses guidelines under Quick Links at Disability Services website and discuss your needs with your professor.

Religious Observances: Campus policy regarding religious observances requires that faculty make every effort to deal reasonably and fairly with all students who, because of religious obligations, have conflicts with scheduled exams, assignments or required attendance. In this class, provide the instructor with a 2-week warning if you are unable to make an exam date due to a religious observance. If regular class lectures are missed, it is up to the student to make up the material. If a homework or project due date falls on a religious observance, then the student must turn in the assignment the day before, or make arrangements with the instructor. See full details at http://www.colorado.edu/policies/fac_relig.html

Discrimination and Harassment: The University of Colorado Boulder (CU-Boulder) is committed to maintaining a positive learning, working, and living environment. The University of Colorado does not discriminate on the basis of race, color, national origin, sex, age, disability, creed, religion, sexual orientation, or veteran status in admission and access to, and treatment and employment in, its educational programs and activities. (Regent Law, Article 10, amended 11/8/2001). CU-Boulder will not tolerate acts of discrimination or harassment based upon Protected Classes or related retaliation against or by any employee or student. For purposes of this CU-Boulder policy, "Protected Classes" refers to race, color, national origin, sex, pregnancy, age, disability, creed, religion, sexual orientation, gender identity, gender expression, or veteran status. Individuals who believe they have been discriminated against should contact the Office of Discrimination and Harassment (ODH) at 303-492-2127 or the Office of Student Conduct (OSC) at 303-492-5550. Information about the ODH, the above referenced policies, and the campus resources available to assist individuals regarding discrimination or harassment can be obtained at <http://www.colorado.edu/odh>

Estimated Lectures and Topics: The following chart shows an estimate of the topics that will be covered and their respective dates. These dates may vary based on the availability of guest lecturers and by the speed and interest of the class. A few "catch-up" dates are allocated if lectures take longer and/or if new topics are added.

Date	Lecture	HW Due	Topics
8/28/2012	1		Intro, Stat OD, Astrodynamics background
8/30/2012	2		Astrodynamics background, MATLAB, Python, LaTeX
9/4/2012	3		Coordinate Systems & Transformations, Numerical Integration
9/6/2012	4	1	Linear Algebra, Probability & Statistics, Observation Types
9/11/2012	5		Formulation of Stat OD, Example of Stat OD in action
9/13/2012	6	2	Least Squares, Minimum Norm, Filters with a priori

			information
9/18/2012	7		Properties of the state transition matrix, Covariance
9/20/2012	8	3	The Batch Processor, Statistics of Least Squares
9/25/2012	9		Batch with a priori, Minimum Variance, Bayesian, Weighted Least Squares
9/27/2012	10	4	Kalman Filtering
10/2/2012	11		Catch-Up
10/4/2012	12	5	Catch-Up
10/9/2012	13		(TA) Review of Concepts
10/11/2012		6	(TA) EXAM 1
10/16/2012	14		(TA) Kalman, Numerical considerations, Joseph, Potter, Cholesky, Square-root Free methods, Unscented
10/18/2012	15	7	Introduce the Final Project
10/23/2012	16		Extended Kalman Filter, Observability,
10/25/2012	17	8	Orthogonal transformations, Givens transformations, a priori
10/30/2012	18		(ISSFD) Kalman filter with process noise, Gauss-Markov
11/1/2012	19	9	(ISSFD) Examples of SNC and DMC
11/6/2012	20		Review of Concepts
11/8/2012		10	EXAM 2
11/13/2012	21		Examples of filters applied to tracking a satellite
11/15/2012	22	11	Dynamic Model Compensation, 2 nd Order Gauss-Markov
11/20/2012	-		Fall Break
11/22/2012	-		Thanksgiving
11/27/2012	23		Smoothing, Monte Carlo
11/29/2012	24	12	OD Accuracy Assessment, Overlaps, Variations, etc.
12/4/2012	25		Project Discussions, workshop
12/6/2012	26		B-Plane mapping, Practical mappings, Rotating covariances
12/11/2012	27		Project Discussions, workshop
12/13/2012	28		Last Day of Classes, MARGIN
12/18/2012	-		Work on Exam 3
12/20/2012	-		Exam 3 and Project DUE