

ASEN5307 – Engineering Data Analysis Methods - Fall 2021

Instructor	Dr. Mark Tschudi (Office: AERO 465, Ph. 492-8274, Email: mark.tschudi@colorado.edu)
Class Time	TTh 2:50 pm – 4:05 pm
Class Location	AERO 111
Class Web Page	http://canvas.colorado.edu
Office Hours	11:00-12:30, 4:15-5:00 TTH & by appt.
Teaching Assistant	(.@colorado.edu)
Required Text	<i>MATLAB Recipes for Earth Sciences</i> , 2015, 4th Edition by Martin H. Trauth, Springer ISBN-13: 978-3662462430
Grading	Take-Home Mid-Term Exam (20%) Take-Home Final Exam (20%) Homework (40%) (10 pts deducted for each day late!) Research Project (20%) 90-100 = A, 80-89 = B, 70-79 = C, 60-69 = D, < 60 = F
Schedule	October 14 – Take-Home Mid-Term Exam December 9 – Research Projects Due, Last Day of Class December 9 – Take-Home Final Exam
Lecture Material	PDF files will be posted on the class website.
Course Overview	Gives students broad exposure to a variety of traditional and modern statistical methods for filtering and analyzing data. Topics include estimation and filtering methods, principal component analyses and spectral analyses. Introduces these methods and provides practical experience with their use. Students carry out problem assignments. Prior knowledge of MATLAB and/or Python is recommended.

Syllabus – ASEN5307

Engineering Data Analysis Methods

I. Introduction

1. Collecting Data
2. Data Calibration and Interpolation
3. Data Editing
4. Presenting Data

II. Statistics and Error Handling

1. Uncertainties in Measurements
2. Empirical Distributions
3. Theoretical Distributions
4. t-test, F-test, χ^2 test
5. Confidence Intervals
6. Correlation Coefficient
7. Degrees of Freedom
8. Estimation Methods
9. Curve Fitting
10. Covariance and Error Analysis
11. Residual Analysis and Data Editing
12. Linear Regression Analysis
13. Bootstrap and Jackknife Estimates
14. Machine Learning 101

III. Time-Series Analysis

1. Fourier Analysis
2. Harmonic Analysis
3. Blackman-Tukey Spectral Analysis
4. Cross-Spectral Analysis
5. Wavelet Analysis
6. Analyzing Unevenly Spaced Data
7. Lomb-Scargle Powerspectrum

IV. Signal Processing

1. Linear Time Invariant Systems
2. Convolution and Filtering
3. Recursive and Nonrecursive Filters
4. Impulse and Frequency Response
5. Filter Design
 - a. Running Mean Filters
 - b. Lanczos-window Cosine Filters
 - c. Butterworth Filters
 - d. Frequency Domain Filtering

V. Spatial Analysis of Data Fields

1. Gridding and Contouring
2. Spherical Harmonics
4. Objective Analysis, Kriging
5. Principal Component Analysis (including SVD)
6. Independent Component Analysis
7. Empirical Orthogonal Functions

SYLLABUS STATEMENTS

CLASSROOM BEHAVIOR

Both students and faculty are responsible for maintaining an appropriate learning environment in all instructional settings, whether in person, remote or online. Those who fail to adhere to such behavioral standards may be subject to discipline. Professional courtesy and sensitivity are especially important with respect to individuals and topics dealing with race, color, national origin, sex, pregnancy, age, disability, creed, religion, sexual orientation, gender identity, gender expression, veteran status, political affiliation or political philosophy. For more information, see the policies on [classroom behavior](#) and the [Student Conduct & Conflict Resolution policies](#).

REQUIREMENTS FOR COVID-19

As a matter of public health and safety due to the pandemic, all members of the CU Boulder community and all visitors to campus must follow university, department and building requirements and all public health orders in place to reduce the risk of spreading infectious disease. Students who fail to adhere to these requirements will be asked to leave class, and students who do not leave class when asked or who refuse to comply with these requirements will be referred to [Student Conduct and Conflict Resolution](#). For more information, see the policy on [classroom behavior](#) and the [Student Code of Conduct](#). If you require accommodation because a disability prevents you from fulfilling these safety measures, please follow the steps in the “Accommodation for Disabilities” statement on this syllabus.

As of Aug. 13, 2021, CU Boulder has returned to requiring masks in classrooms and laboratories regardless of vaccination status. This requirement is a temporary precaution during the delta surge to supplement CU Boulder’s COVID-19 vaccine requirement. Exemptions include individuals who cannot medically tolerate a face covering, as well as those who are hearing-impaired or otherwise disabled or who are communicating with someone who is hearing-impaired or otherwise disabled and where the ability to see the mouth is essential to communication. If you qualify for a mask-related accommodation, please follow the steps in the “Accommodation for Disabilities” statement on this syllabus. In addition, vaccinated instructional faculty who are engaged in an indoor instructional activity and are separated by at least 6 feet from the nearest person are exempt from wearing masks if they so choose.

Students who have tested positive for COVID-19, have symptoms of COVID-19, or have had close contact with someone who has tested positive for or had symptoms of COVID-19 must stay home. In this class, if you are sick or quarantined, please email the instructor as soon as possible if you will be missing class due to COVID-19 or other illness or emergency. You do not need to state any details or provide a note from a doctor. Only state the expected duration of your absence. This class is also available online, with pre-recorded lectures, so the student may be able to stay up-to-date with the class remotely if possible.

ACCOMMODATION FOR DISABILITIES

If you qualify for accommodations because of a disability, please submit your accommodation letter from Disability Services to your faculty member in a timely manner so that your needs can be

addressed. Disability Services determines accommodations based on documented disabilities in the academic environment. Information on requesting accommodations is located on the [Disability Services website](#). Contact Disability Services at 303-492-8671 or dsinfo@colorado.edu for further assistance. If you have a temporary medical condition, see [Temporary Medical Conditions](#) on the Disability Services website.

PREFERRED STUDENT NAMES AND PRONOUNS

CU Boulder recognizes that students' legal information doesn't always align with how they identify. Students may update their preferred names and pronouns via the student portal; those preferred names and pronouns are listed on instructors' class rosters. In the absence of such updates, the name that appears on the class roster is the student's legal name.

HONOR CODE

All students enrolled in a University of Colorado Boulder course are responsible for knowing and adhering to the Honor Code academic integrity policy. Violations of the Honor Code may include, but are not limited to: plagiarism, cheating, fabrication, lying, bribery, threat, unauthorized access to academic materials, clicker fraud, submitting the same or similar work in more than one course without permission from all course instructors involved, and aiding academic dishonesty. All incidents of academic misconduct will be reported to the Honor Code (honor@colorado.edu); 303-492-5550). Students found responsible for violating the academic integrity policy will be subject to nonacademic sanctions from the Honor Code as well as academic sanctions from the faculty member. Additional information regarding the Honor Code academic integrity policy can be found on the [Honor Code website](#).

SEXUAL MISCONDUCT, DISCRIMINATION, HARASSMENT AND/OR RELATED RETALIATION

The University of Colorado Boulder (CU Boulder) is committed to fostering an inclusive and welcoming learning, working, and living environment. CU Boulder will not tolerate acts of sexual misconduct (harassment, exploitation, and assault), intimate partner violence (dating or domestic violence), stalking, or protected-class discrimination or harassment by or against members of our community. Individuals who believe they have been subject to misconduct or retaliatory actions for reporting a concern should contact the Office of Institutional Equity and Compliance (OIEC) at 303-492-2127 or email cureport@colorado.edu. Information about OIEC, university policies, [reporting options](#), and the campus resources can be found on the [OIEC website](#).

Please know that faculty and graduate instructors have a responsibility to inform OIEC when made aware of incidents of sexual misconduct, dating and domestic violence, stalking, discrimination, harassment and/or related retaliation, to ensure that individuals impacted receive information about their rights, support resources, and reporting options.

RELIGIOUS HOLIDAYS

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. See the [campus policy regarding religious observances](#) for full details.