

ASEN5307 – Engineering Data Analysis Methods - Fall 2020

Instructor	Dr. R. Steven Nerem (Office: AERO 456, Ph. 492-6721, Email: nerem@colorado.edu)
Class Time	TTh 11:40 am – 12:55 pm
Class Location	AERO 114 & Zoom
Class Web Page	http://canvas.colorado.edu
Office Hours	2-3 pm TTH (location TBD)
Teaching Assistant	Mary Bastawrous (Mary.Bastawrous@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 15 – Take-Home Mid-Term Exam December 4 – Research Projects Due, Last Day of Class December 4 – 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 Code of Conduct](#).

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 public health orders in place to reduce the risk of spreading infectious disease. Required safety measures at CU Boulder relevant to the classroom setting include:

- maintain 6-foot distancing when possible,
- wear a face covering in public indoor spaces and outdoors while on campus consistent with state and county health orders,
- clean local work area,
- practice hand hygiene,
- follow public health orders, and
- if sick and you live off campus, do not come onto campus (unless instructed by a CU Healthcare professional), or if you live on-campus, please alert [CU Boulder Medical Services](#).

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 policies on [COVID-19 Health and Safety](#) and [classroom behavior](#) and the [Student Code of Conduct](#). If you require accommodation because a disability prevents you from fulfilling these safety measures, please see the “Accommodation for Disabilities” statement on this syllabus.

Before returning to campus, all students must complete the [COVID-19 Student Health and Expectations Course](#). Before coming on to campus each day, all students are required to complete a [Daily Health Form](#).

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 and complete the [Health Questionnaire and Illness Reporting Form](#) remotely. In this class, if you are sick or quarantined, please let the instructor know via email.

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. Violations of the policy may include: 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 at the [Honor Code Office 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 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 cureport@colorado.edu. Information about the OIEC, university policies, [anonymous reporting](#), and the campus resources can be found on the [OIEC website](#). Please know that faculty and 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 options for reporting and support resources.

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. In this class, let the instructor know 2-weeks in advance if you need any accommodations for your religious obligations. See the [campus policy regarding religious observances](#) for full details.

Zoom Information:

Topic: ASEN5307

Time: This is a recurring meeting Meet anytime

Join Zoom Meeting

<https://cuboulder.zoom.us/j/95981756897>

Meeting ID: 959 8175 6897

Passcode: 5307

One tap mobile

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+16699006833,,95981756897# US (San Jose)

Dial by your location

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+1 669 900 6833 US (San Jose)

+1 253 215 8782 US (Tacoma)

+1 312 626 6799 US (Chicago)

+1 646 558 8656 US (New York)

+1 301 715 8592 US (Germantown)

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Find your local number: <https://cuboulder.zoom.us/u/a00QT2S1c>

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162.255.37.11 (US West)

162.255.36.11 (US East)

115.114.131.7 (India Mumbai)

115.114.115.7 (India Hyderabad)

213.19.144.110 (EMEA)

103.122.166.55 (Australia)

64.211.144.160 (Brazil)

69.174.57.160 (Canada)

207.226.132.110 (Japan)

Meeting ID: 959 8175 6897

Passcode: 5307