CHEN 3010 - Applied Data Analysis

Fall 2024, 3 credit hours

MW 1:55pm-3:10pm JSCBB A108

2024-08-26 through 2024-12-12

Instructor

Dr. Katie O'Harra

katie.oharra@colorado.edu

Office: JSCBB E1B47

Office Hours: Mondays, 10:30am - 12:00pm

Note: If it becomes clear that additional space is needed, a location change to a reserved classroom will be announced.

When emailing Dr. O'Harra, please include "CHEN 3010" in email subject line.

Teaching and Course Assistants

Graduate Teaching Assistants:

Lea Hibbard, lea.hibbard@colorado.edu

Kevin Snow, kevin.snow-1@colorado.edu

Advanced Teaching Assistant:

Zach Meduna, zachary.meduna@colorado.edu

Schedule and Location

This course meets on MW 1:55pm-3:10pm @ **Jennie Smoly Caruthers Biotec A108**

Registration Restrictions

Requires prerequisite course of CHEN 1310 and APPM 2360 or MATH 2130 and MATH 3430 (all minimum grade C-). Restricted to College of Engineering students only.

Computer skills required in the course will be facilitated with software including Minitab and Excel, building upon basic Excel skills that you learned in CHEN 1310 (excluding

VBA). The Minitab program will be introduced throughout the course and used for assessment and in-class activities, but is simple and intuitive.

Course Description

Teaches students to analyze and interpret data. Topics include engineering measurements, graphical presentation and numerical treatment of data, statistical inference, and regression analysis. Students will learn to use the software program, Minitab®, as well as statistical tools in Excel®, to provide practical training in analyzing data from real engineering problems. An understanding of the basic principles and approaches to data analysis are of fundamental importance in all areas of chemical and biological engineering, in addition to broader utility across other facets of life.

Textbook and Other Required Materials

Textbook: D.C. Montgomery, G.C. Runger. *Applied Statistics and Probability for Engineers*. Seventh Edition, John Wiley and Sons, 2018.

Software: Excel/Office 365 with Solver/Analysis Toolpak add-ins (earlier versions OK), Minitab (available on the Virtual Desktop or via Cloud Computing – more info later)

Course Communication: Canvas will be used for assessment, lecture content, additional course resources, grades, and announcements.

Course Summary

Important Dates

Midterms 10/7/24 and 11/4/24 (during class period)

HW due W, end of day (11:59pm)

Final 12/17/2024, 4:30 – 7 pm

Standard Grading Scale

A-, A: 90-93, 94-100
B-, B, B+: 80-83,84-86, 87-89
C-, C, C+: 70-73,74-76, 77-79
D-, D, D+: 60-63,64-66, 67-69
F: < 60

Grading Distribution, Assessment

Homework 30%

In-Class Exercises/Workshop Participation 25%

Project (1) 5%

Learning Modules 10%

Midterm Exams (2) 20%

Final 10%

Note: The lowest 5-10% of homework, workshops, and learning module grades will be dropped (exact # TBD).

Outline of Topics

- Introduction, Role of Statistics in Engineering
- Probability, Sample Spaces and Events, Axioms of Probability, Addition Rules
- Conditional Probability, Multiplication Rule, Independence, Bayes' Theorem
- Discrete Variables and Distributions, Uniform and Binomial Distributions
- Geometric, Negative Binomial, Hypergeometric, Poisson Distributions
- Continuous Variables and Distributions, Uniform and Normal Distributions
- Normal Approximations, Exponential, Gamma, Weibull, Lognormal and Beta Distributions
- Joint Probability Distributions, Marginal and Conditional Distributions, Independence
- Covariance and Correlation, Multinomial and Bivariate Normal Distributions, Functions
- Descriptive Statistics, Diagrams and Plots, Probability Plots
- Point Estimation, Sampling Distributions
- Estimators, Bias, Variance, Errors, Estimation Methods
- Confidence Intervals, Mean, Variance Known and Unknown, Variance, Tolerance, Prediction
- Hypothesis Tests, Single Sample, One-and Two-sided, P-values, General Procedure
- Tests on the Mean, Variance Known and Unknown, Choice of Sample Size
- Tests on the Variance and Standard Deviation, Proportion, Goodness of Fit, Nonparametric Tests
- Two-Sample Tests, Comparison of Means
- Nonparametric Tests, Paired t Test, Comparison of Variances, Proportions

- Linear Regression, Straight-Line, Hypothesis Tests
- Confidence Intervals on Regression Parameters, the Mean Response, Predictions, Analysis of Residuals
- Multiple Linear Regression, Matrix Approach
- Hypothesis Tests, Confidence Intervals, Prediction, Model Adequacy
- Polynomial Regression, Selection of Variables, Model Building, Multicollinearity
- Design of Single-Factor Experiments, ANOVA, Analysis of Residuals
- Design of Multiple-Factor Experiments, Two-Factor, Factorial Designs
- General Factorial Experiments
- Blocking and Confounding, Fractional Factorial Designs
- Response Surface Designs

A detailed course schedule will be posted to Canvas separately, with corresponding Student Learning Outcomes, assigned readings, learning modules, help sessions, and due dates.

Course Policies

- All homework, project, or workshop assignments (only if not completed during class) are due at 11:59pm on respective due dates and must be completed by this time. Without a formal extension/excuse (medical situation, emergency, etc. – contact Dr. O'Harra directly), <u>late work will not be accepted.</u>
- Unless otherwise noted, all work is to be submitted electronically on Canvas.
- Learning Modules are short, interactive lectures related to each assigned reading, which will be due *prior* to most of our in-person lectures. These are included within your grading distribution, in order to support students in being equitably prepared and familiar with course content, foundationally equipping individuals and groups for related workshops or other in-class activities.
- <u>An exceedingly high standard of professional quality and clarity is expected on homework and project assignments.</u> Understanding content and its applicability is elevated when you are also able to communicate this knowledge effectively.
- Exams may only be missed for valid medical reasons or official University business. Please give sufficient notice of any expected absences on exam days. Exams missed without a valid excuse are not subject to the above and will be recorded as zeroes.
- Any type of calculator, laptop, tablet, etc. is allowed for use <u>during class</u>. Students **must** bring laptops with the required software to class and related tools to solve problems!
- All electronic devices must run with the volume off during classes/workshops.
- Regular attendance is expected and highly encouraged due to the interactive and incentivized nature of our class meetings!

University Policies

Classroom Behavior

Students and faculty are responsible for maintaining an appropriate learning environment in all instructional settings, whether in person, remote, or online. Failure 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 classroom behavior policy, the Student Code of Conduct, and the Office of Institutional Equity and Compliance.

Requirements for Infectious Disease

Members of the CU Boulder community and visitors to campus must follow university, department, and building health and safety requirements and all applicable campus policies and public health guidelines to reduce the risk of spreading infectious diseases. If public health conditions require, the university may also invoke related requirements for student conduct and disability accommodation that will apply to this class.

If you feel ill and think you might have COVID-19 or if you have tested positive for COVID-19, please stay home and follow the guidance of the Centers for Disease Control and Prevention (CDC) for isolation and testing. If you have been in close contact with someone who has COVID-19 but do not have any symptoms and have not tested positive for COVID-19, you do not need to stay home but should follow the guidance of the CDC for masking and testing.

Accommodation for Disabilities, Temporary Medical Conditions, and Medical Isolation

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.

If you have a required medical isolation for which you require adjustment, please email Dr. O'Harra directly to alert her about your anticipated absence due to illness, injury, or medical isolation.

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 Honor Code may include but are not limited to: plagiarism (including use of paper writing services or technology [such as essay bots]), 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 Student Conduct & Conflict Resolution: honor@colorado.edu, 303-492-5550. Students found responsible for violating the Honor Code will be assigned resolution outcomes from the Student Conduct & Conflict Resolution as well as be subject to academic sanctions from the faculty member. Visit Honor Code for more information on the academic integrity policy.

Sexual Misconduct, Discrimination, Harassment and/or Related Retaliation

CU Boulder is committed to fostering an inclusive and welcoming learning, working, and living environment. University policy prohibits protected-class discrimination and harassment, sexual misconduct (harassment, exploitation, and assault), intimate partner violence (dating or domestic violence), stalking, and related retaliation by or against members of our community on- and off-campus. These behaviors harm individuals and our community. The Office of Institutional Equity and Compliance (OIEC) addresses these concerns, and individuals who have been subjected to misconduct can contact OIEC at 303-492-2127 or email cureport@colorado.edu. Information about university policies, reporting options, and support resources can be found on the OIEC website.

Please know that faculty and graduate instructors must inform OIEC when they are made aware of incidents related to these policies regardless of when or where something occurred. This is to ensure that individuals impacted receive outreach from OIEC about resolution options and support resources. To learn more about reporting and support for a variety of concerns, visit the Don't Ignore It page.

Religious Accommodations

Campus policy requires faculty to provide reasonable accommodations for students who, because of religious obligations, have conflicts with scheduled exams, assignments or required attendance. Please communicate the need for a religious accommodation in a timely manner. In this class,

See the campus policy regarding religious observances for full details.

Mental Health and Wellness

The University of Colorado Boulder is committed to the well-being of all students. If you are struggling with personal stressors, mental health or substance use concerns that are impacting academic or daily life, please contact Counseling and Psychiatric Services (CAPS) located in C4C or call (303) 492-2277, 24/7. Free and unlimited telehealth is also available through Academic Live Care. The Academic Live Care site also provides information about additional wellness services on campus that are available to students.