Course: PHY 335-001

Title: Data Analysis for Physicists

Term: Fall 2022
Credit hours: 2
Meeting days/time/location: White Classroom Building, TR 9:30-10:45 am

Instructor Information

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Office hours: Monday 4-5pm (except during Senate or Department meetings), Thursday 4-5pm.

Course Description

"A computational methods course in the theory and techniques of data analysis and error propagation, with emphasis on applications common to the physical sciences: the treatment of statistical errors, the maximum-likelihood method, the chi-square distribution, and curve fitting. Students will learn computer programming, and they will prepare a set of analysis programs for use in subsequent lab courses."

The course will begin with the application of probability distributions to the characterization of measurement uncertainty, through the central moments such as the mean and standard deviation, and via the parameters of common probability density functions (PDF). It will then treat error analysis using linear error propagation, and the methods maximum likelihood and least squares to estimate the errors in physical measurements. Finally, it will cover the fitting of data to straight lines, generalized linear models, and arbitrary nonlinear functions.

Emphasis will be given to writing numerical routines using the scientific libraries in Python to visualize and analyze data, including manipulation of vectors and matrices, plotting, and functional minimization. Students will develop a Python toolbox of numerical routines which will be useful for analyzing data in PHY 435 and PHY 535. Concepts from linear algebra will be taught and used in the course to simplify calculations. Students will internalize many of these concepts by reading the textbook, watching lectures, and working through a series of laboratories during class.

Course Prerequisites

MA 213, which may be taken concurrently with PHY 335
PHY 232, which may be taken concurrently with PHY 335

Required Materials

Bevington and Robinson, "*Data Reduction and Error Analysis for the Physical Sciences*" (required)
Taylor, "*An Introduction to Error Analysis: The Studies of Uncertainties in Physical Measurements*" (sup)

Associated Expenses

No other expenses.

Activities Outside of Regular Class Meetings

No other activities except lectures and recitations.

Office Hours

I have an open-door policy: come by my office and discuss physics at any time unless my door is closed (for a phone conference or approaching deadline). Please prepare by reading the assigned chapters before coming to my office and turn off cell phones and text messaging while in my office. Office visits may optionally be carried out over Zoom at uky.zoom.us/my/c.crawford. Refer to my schedule at the bottom of https://www.pa.uky.edu/~crawford and email me a request to meet at a certain time (possibly right then if I'm free). Regular office hours are in the format of weekly homework recitations.

Please use the Canvas discussion board instead of email for questions of general interest. Please respond to each other's questions. The instructor will monitor and participate in discussions.

Skill and Technology Requirements

We will study problems numerically using open-source Python scientific libraries, which are freely available on the internet.

For technical/account help, students can contact Information Technology Services by phone 859-218-HELP (4357) and via the ITS Customer Services page. (https://www.uky.edu/its/customer-support-student-it-enablement/customer-services)

Student Learning Outcomes

After completing this course, the student will be able to:

1. Characterize the statistical uncertainty of measurements using probability distributions.
2. Estimate parameters of standard probability density functions from sample data.
3. Calculate the weighted mean, standard deviation, and covariance of an experimental data set.
4. Propagate errors to functions of one or more random variables.
5. Perform least squares curve fitting to a straight line, generalized linear, and nonlinear models.
6. Perform data visualization and analysis, including the above tasks, in Python.

Course Details

Tentative Course Schedule

The class will meet for the first 10 weeks of the semester. The complete schedule will be published in Canvas, including daily reading assignments, quizzes, and weekly homework assignments, and laboratories. Students must complete the assigned reading, watch the published online lecture, and take an online quiz before each class. The first few minutes of class will be devoted to a discussion the reading and lecture, answering questions, and performing occasional demonstrations or experiments. The bulk of each class will be dedicated to solving specific problems from the weekly homework assignment and working on labs in groups of two. Thus, students should be able to complete most of the homework during class, while most of the work at home should spent preparing for each class. Office hours will be held in the format of optional recitations to help students catch up on the homework or discuss principles more in-depth than can be done in the beginning of each class.

Course Activities and Exams

An online quiz must be completed in Canvas prior to the beginning of each class. Quizzes typically contain three questions worth one point each and are graded electronically for immediate feedback.

5 of the quizzes will be dropped, but the scores will still contribute as extra credit, so it is possible to get above 100% in the quiz category. As an alternative to each quiz, the student may submit a reading journal entry at the time of the quiz, which will be graded on the scale of 1 (partial), 2 (complete), or 3 (exemplary). It is not sufficient to simply turn in notes from the readings; the reading journal but must demonstrate substantial evidence of actively processing the material.

A homework assignment will be due approximately every 1-2 weeks, worth approximately 100 pts each. Each assignment will be weighted by its total points. The goal is to complete most of the homework together in groups during class. There will be an optional recitation each week to wrap up the homework and for in-depth discussion of difficult concepts learned that week.

There will be no exams in this course, but a final project instead.

Grading Scale

Grades will be recorded and calculated in Canvas. Extra credit will be awarded for finding new errors in the textbook or solving special questions posed during class. The total grade is weighted from assignments, quizzes and exams and assigned a letter grade according to the tables below.

Component weighting:		*Grading scale:*
20%	Quizzes	*85 – 100% = A*
20%	Homework	*70 – 84% = B*
20%	Laboratories	*55 – 69% = C*
20%	Toolbox	*40 – 54% = D*
20%	Project	*Below 40% = E*

Midterm Grades

Midterm grades will be calculated based on graded quizzes, homework, and laboratories, proportionally weighted by the above table.

For undergraduates, midterm grades will be posted in myUK by the deadline established by the University Senate and published in the Academic Calendar. (http://www.uky.edu/registrar/content/academic-calendar).

Attendance Policy

There is no explicit attendance requirement, either in person or online, except for the midterm and final exams. Our goal is that classes will be a valuable resource for understanding the online lectures and completing the homework assignments in a timely manner. However, it is important to prepare for class to benefit the most from our time together.

Assignment Policies

Assignment Submissions

All homework and laboratories will be submitted electronically in Canvas before midnight of the assigned due date. Scanned copies, electronic ink, or typed solutions will be submitted as a single PDF file, with supplements, including computer code or spreadsheets, attached as separate files. Please do not attach photographs of individual pages because they are incompatible with the online grading

platform. There are free cell phone applications to take pictures of documents and export them as a pdf file.

Returning Assignments to Students

Online quizzes will be graded electronically for immediate feedback before each class. The instructor will return graded homework assignments within one week (maximum of two weeks). The midterm exam will be returned and reviewed during the next class following the exam. Final exams will not be returned but can be reviewed in the instructor's office.

Late Assignments

There is a penalty of 25% per class for late homework. Arrangements must be made with the instructor prior to the due date to receive a homework extension. Late assignments will be accepted for excused absences, if the student contacts the instructor prior to the due date and provides documentation of the excused absence, per the University Senate Rules (https://www.uky.edu/universitysenate/rules-regulations).

Assignments Due during Prep Week

No homework is scheduled during Prep Week.

Academic Policy

The complete University academic policy respect to this course is available in the Senate's Academic Policy Statements (https://www.uky.edu/universitysenate/acadpolicy).

Academic Offenses (Cheating, Plagiarism, and Falsification or Misuse of Academic Records)

While students will solve homework problems in groups, each student is responsible to turn in their own work. Copying homework or exams from people, solution manuals, online, or any other source is plagiarism and will not be tolerated. University policies and procedures regarding cheating and other academic offenses will be strictly adhered to and can be reviewed at Rules Regarding Academic Offenses (https://www.uky.edu/universitysenate/ao).

Resources

A list of course resources including reference material is maintained at the bottom of the course homepage (https://www.pa.uky.edu/~crawford/phy335_fa22).

Diversity, Equity, and Inclusion

*The University of Kentucky is committed to our core values of diversity and inclusion, mutual respect and human dignity, and a sense of community (*Governing Regulations XIV*). We acknowledge and respect the seen and unseen diverse identities and experiences of all members of the university community (*https://www.uky.edu/regs/gr14*). These identities include but are not limited to those based on race, ethnicity, gender identity and expressions, ideas and perspectives, religious and cultural beliefs, sexual orientation, national origin, age, ability, and socioeconomic status. We are committed to equity and justice and providing a learning and engaging community in which every member is engaged, heard, and valued.*

We strive to rectify and change behavior that is inconsistent with our principles and commitment to diversity, equity, and inclusion. If students encounter such behavior in a course, they are encouraged to speak with the instructor of record and/or the Office of Institutional Equity and Equal Opportunity. *Students may also contact a faculty member within the department, program director, the director of undergraduate or graduate studies, the department chair, any college administrator, or the dean. All of these individuals are mandatory reporters under University policies.* (https://www.uky.edu/universitysenate/syllabus-dei)]

Student Resources

The University offers a variety of resources to students. Visit the University Senate's Resources Available to Students to access that list (https://www.uky.edu/universitysenate/student-resources).

Classroom Behavior Policies

Laptop computers will be regularly used during class. Use of cellphones and other technology, is permitted but must not disrupt the learning of others. Because the classroom is largely based on group work it is especially important to use respectful language and cultivate an inclusive environment.

Course evaluation

Course evaluations are an important component of our Department's instructional program. We value your feedback on both the course content and instructor. The standard university TCE eXplorance Blue (http://www.uky.edu/eval) will be used to collect evaluations via your computer, tablet, or smart phone. You will receive a reminder email near the end of the semester with instructions. We would also appreciate immediate feedback at http://www.pa.uky.edu/~crawford/phy335 fa22/feedback.html and will address issues or incorporate suggestions into the course in a timely manner.

Course Recordings

The University of Kentucky Code of Student Conduct defines Invasion of Privacy as using electronic or other devices to make a photographic, audio, or video record of any person without their prior knowledge or consent when such a recording is likely to cause injury or distress.

This course includes prerecorded video lectures. All video and audio recordings of lecturers and class meetings are for educational use only. They and are not to be copied, shared, or redistributed.

As addressed in the Code of Student Conduct, students are expected to follow appropriate university policies and maintain the security of linkblue accounts used to access recorded class materials. Recordings may not be reproduced or uploaded to other online environments.

Video and audio recordings by students are not permitted during the class unless the student has received prior permission from the instructor. Any sharing, distribution, and or uploading of these recordings outside of the parameters of the class is prohibited. Students with specific recording accommodations approved by the Disability Resource Center should present their official documentation to the instructor.

Course Copyright