Error Analyses and Optimization Methodologies in Materials Research

EMA 3800

Class Periods: MWF, Period 7, and 1:55pm – 2:45pm

Location: NZH0112

Academic Term: Spring 2024

Instructor:

Victoria M Miller (she/her/hers)
victoria.miller@ufl.edu
(352) 846-3373
Office Hours: TBD

Teaching Assistant/Peer Mentor/Supervised Teaching Student:

- TBD

Course Description

Statistical approach for materials research, basic and relevant statistical concepts, error analyses, factorial matrices, reducing the variance, nested designs and sampling plans, mixture designs, optimization technology, response surface method and Taguchi.

Course Pre-Requisites / Co-Requisites

Corequisite: EMA3010

Course Objectives

Students will develop fluency with multiple methods of statistical analysis and experimental design.
Students will become comfortable with data methods in materials science: designing experiments to generate data, using code to manipulate and perform statistical tests on data, and using data to draw valid conclusions about a scientific question.

Materials and Supply Fees

n/a

Relation to Program Outcomes (ABET):

Outcome	Coverage*
1. An ability to identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics	Low
2. An ability to apply engineering design to produce solutions that meet specified needs with consideration of public health, safety, and welfare, as well as global, cultural, social, environmental, and economic factors	High
3. An ability to communicate effectively with a range of audiences	Low
4. An ability to recognize ethical and professional responsibilities in engineering situations and make informed judgments, which must consider the impact of engineering solutions in global, economic, environmental, and societal contexts	
5. An ability to function effectively on a team whose members together provide leadership, create a collaborative and inclusive environment, establish goals, plan tasks, and meet objectives	

6. An ability to develop and conduct appropriate experimentation, analyze and interpret data, and use engineering judgment to draw conclusions	Medium
7. An ability to acquire and apply new knowledge as needed, using appropriate learning strategies	

Required Textbooks and Software

- Design and Analysis of Experiments
- Douglas C. Montgomery
- 7th Edition, Wiley (Other recent editions are also acceptable.)
- 9780470169

Recommended Materials

- An Introduction to Error Analysis: The Study of Uncertainties in Physical Measurements
- John R. Taylor
- 2nd edition, 1996
- 093570275X

MATLAB is used extensively in this course. MATLAB and all necessary toolboxes are available free for your use through UF Apps, but in previous years many students have complained about the reliability of UF Apps. If you desire, you can purchase a MATLAB license for yourself (including the important toolboxes) for $99. https://www.mathworks.com/products/matlab/student.html

Course Schedule

The course schedule is subject to change, but will be kept up to date on Canvas. The following topics will be covered:

- Week 1: Basic coding, plotting data, file I/O
- Week 2: Introduction to MATLAB, linear algebra
- Week 3: Scientific method
- Week 4: Basic statistics (distributions and probability)
- Week 5: Basic statistics (t-tests)
- Week 6: Basic statistics (one-way ANOVA)
- Week 7: Basic statistics (multi-way ANOVA)
- Week 8: Multiple linear regression
- Week 9: Multiple linear regression (variable transforms)
- Week 10: Factorial designs
- Week 11: Response surface methodology
- Week 12: Propagation of uncertainty
- Week 13: Bayes theorem
- Week 14: Simple experimental design with JMP
- Week 15: Advanced experimental design with JMP

Attendance Policy, Class Expectations, and Make-Up Policy

- Homework
  - Homework will be assigned approximately weekly.
  - Late assignments will be accepted until homework solutions are posted. Students will lose 10% of the total points each day or portion thereof that the assignment is late.
- Attendance and Absences
  - You should attend lecture in person regularly; lectures will be recorded, but the recordings will only be released if at least 60% of the class attends in-person.

    - For some sections of the class (e.g. MATLAB bootcamp) there will be additional recordings posted online in advance, then the in class section will be used for practice and "follow along" examples. It is expected that students watch the recordings in advance if they do not know the material already; the in-class sections will not be a repeat of the recordings.
    - If you are sick (with covid or anything else) please let me know! I can work with you if I know, but I'm not psychic.
    - Verification of an absence may be required in extreme circumstances, e.g. missing a midterm exam without notice. Excused absences must be consistent with university policies in the undergraduate catalog (https://catalog.ufl.edu/ugrad/current/regulations/info/attendance.aspx) and require appropriate documentation.
- "Quizzes"
    - Unannounced quizzes (approx. 10 minutes duration) will be posted to Canvas periodically. They will be primarily graded for completion, and I will go over the answers in class.
    - Students can make up quizzes with the standard late policy, no questions asked.
    - The quizzes are meant to both force you to keep current with the lectures and to show me what concepts the class is struggling with.
- Extra Credit
    - Students that make a useful demo that I can use in class will receive up to five extra credit points (based on demo quality) to be assigned to the lowest homework grade. "Standard" projects will receive 3 points, with additional points awarded for exceptional work. In order to receive credit, student must provide a typed description of the class concept being demonstrated (minimum of a half page single spaced). Within reason, there is no maximum number of demos a student can submit. Extra credit will be accepted until the last day of classes. A maximum of one demo per week per student will be accepted.
    - Additional opportunities for extra credit may be announced during lecture.
- Project
    - For your project, you will work in groups of 3-4. You will find a full-length scientific paper in the field of materials science and engineering in which multiple types of quantitative data are collected and analyzed. First, you will summarize the data types collected, how the experiments were designed, and the methods of data analysis that were employed. Second, you will describe what was done well and what needed to be improved in the experimental design and data analysis. Are the authors' scientific/engineering conclusions valid? You will get feedback after each deliverable.
    - For extra credit: Many recently published papers also publish the raw data alongside the manuscript. Re-process the data using the data analysis method(s) that you proposed and use it to support your own engineering conclusions.
- Be Nice!
    - Incivility toward students, staff, or faculty will not be tolerated.
    - If you'd like me to call you by a different name, different pronouns, etc. just let me know!

Requirements for class attendance and make-up exams, assignments, and other work in this course are consistent with university policies. Click here to read the university attendance policies: https://catalog.ufl.edu/UGRD/academic-regulations/attendance-policies/

Evaluation of Grades

Assignment	Percentage of Final Grade
Homework Sets	40%
Quizzes	15%
Midterm Exam	15%
Final Exam	15%
Project	15%
	100%

Grading Policy

Percent	Grade	Grade Points
93.0 - 100.0	A	4.00
90.0 - 92.9	A-	3.67
87.0 - 89.9	B+	3.33
83.0 – 86.9	B	3.00
80.0 - 82.9	B-	2.67
77.0 - 79.9	C+	2.33
73.0 – 76.9	C	2.00
70.0 - 72.9	C-	1.67
67.0 - 69.9	D+	1.33
63.0 - 66.9	D	1.00
60.0 - 62.9	D-	0.67
0 - 59.9	E	0.00

More information on UF grading policy may be found at:
https://catalog.ufl.edu/ugrad/current/regulations/info/grades.aspx

Students Requiring Accommodations
Students with disabilities who experience learning barriers and would like to request academic accommodations should connect with the disability Resource Center by visiting https://disability.ufl.edu/students/get-started/. It is important for students to share their accommodation letter with their instructor and discuss their access needs, as early as possible in the semester.

Course Evaluation
Students are expected to provide professional and respectful feedback on the quality of instruction in this course by completing course evaluations online via GatorEvals. Guidance on how to give feedback in a professional and respectful manner is available at https://gatorevals.aa.ufl.edu/students/. Students will be notified when the evaluation period opens, and can complete evaluations through the email they receive from GatorEvals, in their Canvas course menu under GatorEvals, or via https://ufl.bluera.com/ufl/. Summaries of course evaluation results are available to students at https://gatorevals.aa.ufl.edu/public-results/.

In-Class Recording
Students are allowed to record video or audio of class lectures. However, the purposes for which these recordings may be used are strictly controlled. The only allowable purposes are (1) for personal educational use, (2) in connection with a complaint to the university, or (3) as evidence in, or in preparation for, a criminal or civil proceeding. All other purposes are prohibited. Specifically, students may not publish recorded lectures without the written consent of the instructor.

A "class lecture" is an educational presentation intended to inform or teach enrolled students about a particular subject, including any instructor-led discussions that form part of the presentation, and delivered by any instructor hired or appointed by the University, or by a guest instructor, as part of a University of Florida course. A class lecture does not include lab sessions, student presentations, clinical presentations such as patient history, academic exercises involving solely student participation, assessments (quizzes, tests, exams), field trips, private conversations between students in the class or between a student and the faculty or lecturer during a class session.

Publication without permission of the instructor is prohibited. To "publish" means to share, transmit, circulate, distribute, or provide access to a recording, regardless of format or medium, to another person (or persons), including but not limited to another student within the same class section. Additionally, a recording, or transcript of a recording, is considered published if it is posted on or uploaded to, in whole or in part, any media platform, including but not limited to social media, book, magazine, newspaper, leaflet, or third party note/tutoring services. A student who publishes a recording without written consent may be subject to a civil cause of action instituted by

a person injured by the publication and/or discipline under UF Regulation 4.040 Student Honor Code and Student Conduct Code.

University Honesty Policy

UF students are bound by The Honor Pledge which states, "We, the members of the University of Florida community, pledge to hold ourselves and our peers to the highest standards of honor and integrity by abiding by the Honor Code. On all work submitted for credit by students at the University of Florida, the following pledge is either required or implied: "On my honor, I have neither given nor received unauthorized aid in doing this assignment." The Honor Code (https://sccr.dso.ufl.edu/process/student-conduct-code/) specifies a number of behaviors that are in violation of this code and the possible sanctions. Furthermore, you are obligated to report any condition that facilitates academic misconduct to appropriate personnel. If you have any questions or concerns, please consult with the instructor or TAs in this class.

Commitment to a Safe and Inclusive Learning Environment

The Herbert Wertheim College of Engineering values varied perspectives and lived experiences within our community and is committed to supporting the University's core values, including the elimination of discrimination. It is expected that every person in this class will treat one another with dignity and respect regardless of race, creed, color, religion, age, disability, sex, sexual orientation, gender identity and expression, marital status, national origin, political opinions or affiliations, genetic information, and veteran status.

If you feel like your performance in class is being impacted by discrimination or harassment of any kind, please contact your instructor or any of the following:

- Your academic advisor or Graduate Program Coordinator
- HWCOE Human Resources, 352-392-0904, student-support-hr@eng.ufl.edu
- Curtis Taylor, Associate Dean of Student Affairs, 352-392-2177, taylor@eng.ufl.edu
- Toshikazu Nishida, Associate Dean of Academic Affairs, 352-392-0943, nishida@eng.ufl.edu

Software Use

All faculty, staff, and students of the University are required and expected to obey the laws and legal agreements governing software use. Failure to do so can lead to monetary damages and/or criminal penalties for the individual violator. Because such violations are also against University policies and rules, disciplinary action will be taken as appropriate. We, the members of the University of Florida community, pledge to uphold ourselves and our peers to the highest standards of honesty and integrity.

Student Privacy

There are federal laws protecting your privacy with regards to grades earned in courses and on individual assignments. For more information, please see: https://registrar.ufl.edu/ferpa.html

Campus Resources:

Health and Wellness

U Matter, We Care:

Your well-being is important to the University of Florida. The U Matter, We Care initiative is committed to creating a culture of care on our campus by encouraging members of our community to look out for one another and to reach out for help if a member of our community is in need. If you or a friend is in distress, please contact umatter@ufl.edu so that the U Matter, We Care Team can reach out to the student in distress. A nighttime and weekend crisis counselor is available by phone at 352-392-1575. The U Matter, We Care Team can help connect students to the many other helping resources available including, but not limited to, Victim Advocates, Housing staff, and the Counseling and Wellness Center. Please remember that asking for help is a sign of strength. In case of emergency, call 9-1-1.

Counseling and Wellness Center: https://counseling.ufl.edu, and 392-1575; and the University Police Department: 392-1111 or 9-1-1 for emergencies.

Sexual Discrimination, Harassment, Assault, or Violence
If you or a friend has been subjected to sexual discrimination, sexual harassment, sexual assault, or violence contact the **Office of Title IX Compliance**, located at Yon Hall Room 427, 1908 Stadium Road, (352) 273-1094, title-ix@ufl.edu

Sexual Assault Recovery Services (SARS)
Student Health Care Center, 392-1161.

University Police Department at 392-1111 (or 9-1-1 for emergencies), or http://www.police.ufl.edu/.

Academic Resources

E-learning technical suppor*t*, 352-392-4357 (select option 2) or e-mail to Learning-support@ufl.edu. https://lss.at.ufl.edu/help.shtml.

Career Connections Center, Reitz Union, 392-1601. Career assistance and counseling; https://career.ufl.edu.

Library Support, http://cms.uflib.ufl.edu/ask. Various ways to receive assistance with respect to using the libraries or finding resources.

Teaching Center, Broward Hall, 392-2010 or 392-6420. General study skills and tutoring. https://teachingcenter.ufl.edu/.

Writing Studio, 302 Tigert Hall, 846-1138. Help brainstorming, formatting, and writing papers. https://writing.ufl.edu/writing-studio/.

Student Complaints Campus*:* https://sccr.dso.ufl.edu/policies/student-honor-code-student-conduct-code/;https://care.dso.ufl.edu.

On-Line Students Complaints*:* https://distance.ufl.edu/getting-help/; *https://distance.ufl.edu/state-authorization-status/#student-complaint*.