

## EMA 6808 Error Analysis, Optimization, and Statistical Experimental Design in Materials Research

1, Catalog Description (including credit hours) – This is a basic course in designing experiments and analyzing the resulting data. The course deals with the types of experiments that are frequently conducted in industrial settings.

The course objective is to learn to plan, design and conduct experiments efficiently and effectively, and analyze the resulting data to obtain objective conclusions. Both design and statistical analysis issues are discussed. Opportunities to use the principles taught in the course arise in all phases of engineering work, including new product design and development, process development, and manufacturing process improvement. Applications from various fields of engineering (including chemical, mechanical, electrical, materials science, industrial, etc.) will be illustrated throughout the course. Computer software packages to implement the methods presented will be illustrated extensively, and you will have opportunities to use it for homework assignments and the term project. 3 credits.

2. Pre-requisites and Co-requisites – EMA 3800 or equivalent.

### 3. Course Objectives

The course will have the student apply Error Analysis, Statistical Design of Experiments, Comparison of Two or More Treatments, Balanced Block Design, Factorial Designs, Lab & Industrial Applications, Fractional Factorials, Screening Techniques, Least Square Theory, Regression Analysis, Optimization Techniques and Surface Responses to engineering problems in order to develop the skills necessary to apply these approaches to the student's research efforts.

4. Contribution of course to meeting the professional component.

Professional Component	# of credits
Math and science.	
Engineering.	3
General education.	
Other.	
Does it contain design (Y or N)?	Y

5. Relationship of course to program outcomes

Outcome	Assessed?	Assessment Method
a: Apply knowledge of math, science, and engineering.	X	Test Questions
b1: Conduct experiments, analyze and interpret data.	X	Term Project
b2: Conduct statistical analysis.	X	Test Questions & Term Project
c: Solve materials selection and design problems.		
d: Function on teams.	X	Term Project
e: Identify, formulate, and solve engineering problems.	X	Test Questions
f: Understand professional and ethical responsibility.		
g: Communicate effectively.	X	Term project.
h1: Understand economic impact.		

h2: Understand global, societal, and environmental impact.		
i: Engage in lifelong learning.		
j: Knowledge of contemporary issues.		
k: Use techniques, skills, and tools of MSE.	X	Test Questions and Term project

6. Instructor – John J. Mecholsky, Jr.

- a. Office location: 237A Rhines Hall
- b. Telephone: 352-846-3306 (office)
- c. E-mail address: jmech@mse.ufl.edu
- d. Class Web site: login to e-Learning at <https://lss.at.ufl.edu/>
- e. Office hours: M-W-F 9:30AM-10:30AM

7. Teaching Assistant – TBD

- a. Office location:
- b. Telephone
- c. E-mail address:
- d. Office hours:

8. Meeting Times – Lecture: M-W-F 2,

9. Class/laboratory schedule – Three 50 minute lecture periods per week.

10. Meeting Location – NEB 201

11. Material and Supply Fees – None

12. Textbooks and Software Required

- a. **Design and Analysis of Experiments. 8<sup>th</sup> Edition**
- b. D. C. Montgomery
- c. 2013, 8<sup>rd</sup> Edition
- d. 978-1-118-14692-7

**13. Recommended Reading – Principles of Experimental Design and Analysis, Alberto Garcia-Diaz and Don Phillips, Chapman & Hall, First Edition, 1995; Statistics in Research and Development, R. Caulcutt, Chapman & Hall, Second Edition, 1991; Statistical Design and Analysis of Experiments, with Applications to Engineering and Science, R. L. Mason, R. F. Gunst, and J.L. Hess, J. Wiley and Sons, 1989.**

**14. Course Outline –**

**The Engineered/Design Approach for Materials Research: (Ch.1-2)**

Introduction to DOE and review of basic statistical concepts-Problem definition, System identification, Data collection, Statistical analysis

**Materials Experimental Error Analysis**

**(Ch.3)**

- Analysis of Variance “ANOVA”

- Reducing the Variance
- Choice of sample size

### **Application of DOE for Materials Problems**

(Ch 4)

- The

randomized complete block design (RCBD),

- Latin Squares,

### **Factorial Designs**

(Ch 5, 6, 7)

- Two Level Factorials, The  $2^k$  factorials,
- Blocking and confounding in two level factorial designs

### **Fractional Factorial Designs**

(Ch 8)

- Fractional Factorials,  $2^{k-1}$  designs, defining relation, Generators of the designs, and the resolution of the design,  $2^{k-p}$  designs,
- Screening designs

### **Optimization Techniques and Surface Responses**

(Ch 11)

- Rotatable designs Central composite design,
- Steepest ascent and steepest descent methods
- Complex Materials Analysis using
- Mixtures designs; Simplex Designs for K variables

### **Random Factors in experiments**

(Ch 12)

### **Nested designs**

(Ch 13)

15. Attendance and Expectations - Attendance in lecture is not part of the course grade; however, all students are expected to attend class. The class is taught in an interactive lecture format, and includes discussion and practice problems. Cell phones should be turned off in class. Reading of newspapers, work on assignments for this or other classes, or other activities that are not part of the class are not allowed during class time.
16. Grading – Grade in this course will be determined by scores of 10 homework assignments (50%) two interim project reports (10%) each, and a final project report (30%). Information on current UF grading policies for assigning grade points can be found at <http://www.registrar.ufl.edu/catalog/policies/regulationgrades.html>.

Term Project - The project consists of planning, designing, conducting and analyzing an experiment, using appropriate DOE principles. Two written interim project reports are required, along with a final written project report. The dates these items are due is on the course outline above. The term project may be performed in teams of up to three people or by one person. You must inform the instructor of the decision as to the author(s) of the project. The context of the project experiment is limited only by your imagination. You may choose to conduct experiments directly connected to your own research. This can be an extra benefit from this course; it can help you finish your research sooner. For industrial participants or those with an internship in industry, a project that they are involved with at work is a good possibility. If all else fails, you could conduct a “household” experiment (such as how does varying factors such as type of cooking oil, amount of oil, cooking temperature, pan type, brand of popcorn, etc. affect the yield and taste of popcorn). You are encouraged to be creative.

The major requirement is that the experiment must involve at least three design factors.

Each of the interim reports requires information about the problem, the factors, the responses that will be observed, and the specific details of the design that will be used.

You will be given feedback on these reports that should help you in completing the final experiment and the analysis, and preparing the final report.

17. Grading Scale - The grading scale is indicated below. Grades are not curved.

Percentage	≥92	≥88	≥84	≥80	≥76	≥72	≥68	≥65	≥62	≥59	≥56	<56
Letter Grade	A	A-	B+	B	B-	C+	C	C-	D+	D	D-	E
Grade Points	4.0	3.67	3.33	3.0	2.67	2.33	2.0	1.67	1.33	1.0	0.67	0

For more information on grades and grading policies, please visit:

<https://catalog.ufl.edu/ugrad/current/regulations/info/grades.aspx>

18. Make-up Exam Policy - Homework may not be turned in late without prior approval of the instructor. Make-up exams are given only for reasons of illness and in accordance with University of Florida regulations.

19. Honesty Policy – All students admitted to the University of Florida have signed a statement of academic honesty committing themselves to be honest in all academic work and understanding that failure to comply with this commitment will result in disciplinary action. This statement is a reminder to uphold your obligation as a UF student and to be honest in all work submitted and exams taken in this course and all others.

Cheating is a very serious offense and will not be tolerated. All instances of cheating, no matter how minor it may seem to you, will be reported to the Dean of Students Office and prosecuted. Penalties for cheating are severe and may include a grade of E for the semester. Actions that are considered cheating include, but are not limited to:

- Copying of homework solutions from another source or another student. Students are encouraged to work together to solve the homework, and thus it is expected that in some cases the homework solutions of two students will be the same. However, blatant copying can be identified and will be considered cheating.
- Copying from another student during an exam, or using disallowed resources (including programming information into a calculator) during an exam. Calculators will be spot-checked during exams.
- Plagiarism on any written assignment. Plagiarism is the practice of copying the text or information from other sources and presenting it as your own. Any phrase of more than four words that is taken directly from another text needs to be placed into quotation marks and properly attributed.
- Attempting to change answers or marked grades on homework assignments or exams after they have been graded and returned.
- Any other action which is an attempt to modify your grade for an assignment in a way that does not actually reflect your work or abilities.

20. Accommodation for Students with Disabilities – Students Requesting classroom accommodation must first register with the Dean of Students Office. That office will provide the student with documentation that he/she must provide to the course instructor when requesting accommodation.

21. UF Counseling Services –Resources are available on-campus for students having personal problems or lacking clear career and academic goals. The resources include:

- UF Counseling & Wellness Center, 3190 Radio Rd, 392-1575, psychological and psychiatric services.
- Career Resource Center, Reitz Union, 392-1601, career and job search services.

22. Software Use – All faculty, staff and student 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.