IEEM 510500 Statistical Methods

Spring 2010
Monday 18:20-21:10 pm

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Office hours: (MW)16:30pm – 18:00pm or by appointment

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Textbook: *Design and Analysis of Experiments*, 7th edition (or the latest versuib), by D.C. Montgomery, John Wiley & Sons, New York, 2009.

About the Course

This is a basic course in designing experiments and analyzing the resulting data. It is intended for engineers, physical/chemical scientists and scientists from other fields such as biotechnology and biology. The course deals with the types of experiments that are frequently conducted in industrial settings. The prerequisite background is a basic working knowledge of statistical methods. A formal course in engineering statistics at the level of ECE 380 is the official prerequisite, but this specific course isn't essential. You will need to know how to compute and interpret the sample mean and standard deviation, have previous exposure to the normal distribution, be familiar with the concepts of testing hypotheses (the *t*-test, for example), constructing and interpreting a confidence interval, and model-fitting using the method of least squares. Most of these ideas will be reviewed as they are needed.

The course objective is to learn how 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 and scientific work, including technology development, 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 (Design-Expert, JMP) to implement the methods presented will be illustrated extensively, and you will use these packages for homework assignments and the term project.

All experiments conducted by engineers and scientists are *designed* experiments; some of them are poorly designed, and others are well-designed. Well-designed experiments allow you to obtain reliable, valid results faster, easier, and with fewer resources than with poorly-designed experiments. You will learn how to plan, conduct and analyze experiments efficiently in this course. A well-designed experiment can lead to reduced development lead time for new processes and products, improved manufacturing process performance, and products that have superior function and reliability.

The course schedule and outline contains assigned **reading topics** from the textbook and suggested **homework problems**. In addition to the textbook reading assignments you may also want to read some of the **supplemental text material** for each chapter. This material is found on the World Wide Web page for the book maintained by the publisher, John Wiley & Sons. See the text Preface for more details. The JMP and Design-Expert computer software packages can be used to solve most of the problems in the textbook.

Tentative course schedule

1. Introduction (Chap. 1)
2. Simple Comparative Experiments (Chap. 2)
3. Experiments with a Single Factor: The Analysis of Variance (Chap. 3)
4. Randomized Blocks, Latin Squares and Related Designs (Chap. 4)
5. Introduction to Factorial Designs (Chap. 5)
6. The 2^k Factorial Design (Chap. 6, 7)
7. Two-Level Fractional Factorial Designs (Chap. 8)
8. Response Surface Methods and Designs (Chap. 9)

Grading

Your grade in the course will be determined by the (unannounced) quiz (10%), the midterm exam (25%), the final exam (35%), class participation (10%) and the term project (20%).
Midterm exam: 4/11 18:20-20:00 pm
Final exam: 6/20 18:20-20:00 pm

Term Project

The term project is performed in teams of up to three people. The project consists of planning, designing, conducting and analyzing an experiment, using appropriate DOX 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 context of the term project experiment is limited only by your imagination. In previous classes, students have conducted experiments directly connected to their own research projects. The project is a nice way to get extra-mileage 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). However, I've seen just about all the possible popcorn (and catapult and paper airplane) experiments than can be run, and I'm looking for a little variety in my life, so let's 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. Some of these projects may be selected for class discussion/presentation, if time permits. More details will be announced in later class.