Abbreviated Syllabus -- INEG 5333 Design of Industrial Experiments

Instructor: Greg Hutto

Term and date: Winter 2 2020 (4 Mar – 30 Apr 2020)
Online Offering
Instructor name and contact information:
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Office Hours: Flexible based upon contacting instructor via email to set up an appointment. I intend to negotiate with the class a mutually agreeable time for a weekly live session to work problems and answer questions. This session will be recorded for those unable to attend.

Course Description:

Required Textbook:

Design and Analysis of Experiments; Montgomery, D., 9th ed, 2013 McGraw Hill. ISBN-13: 978-0071799249.

Purpose:

The scientific, industrial, medical, and engineering worlds are filled with complex problems and processes where multiple conditions may bear on the process outcome. Stable medicine formulations, improved battery life and safety, understanding of graphene composite material properties, and reducing the defect rate in a bottling plant are all practical examples of such problems. The science of multi-factor experimentation can replace intuition (inspired tinkering), test cases, and varying one factor at a time as a reliable problem-solving approach. This science has over 100 years practical success in every field of endeavor; the instructor has been teaching and practicing industrial and military experimentation for more than 30 years. The student will learn how to plan, design and conduct experiments efficiently and effectively, and analyze the resulting data to obtain useful conclusions: in short, to rapidly, efficiently, and unerringly find a path that is true and reliable.

Course Objectives:

To achieve the course purpose, students at the end of the course should have mastered fundamental concepts and principles to:

1. Trace & describe experimental design history from idiosyncratic Renaissance scientists to Gosset's 2 sample to Fisher's factorial/ANOVA, and modern developments
2. take word problem, write one or more objectives, define responses to meet objective(s), brainstorm many possible influential conditions, prioritize them, and determine experimental control approach
3. Describe the factorial menu from single factor to 2(k-p) family, general factorial, optimal, and response surface. Given a practical problem, choose one or more to apply to problem.
4. Build the chosen design by applying algorithm to place points in space. Effectively choose among options for customizing the design to the particular problem at hand.
5. With chosen design evaluate design metrics for sufficiency of power & orthogonality. As needed, add replicates, center or other lack of fit points to bring design to excellence.

6. Based on initial experiment(s), choose augmentation scheme (replicate, project, fold over, optimal, response surface, confirm) for next round of experiments
7. Explain why and then arrange a design in suitable blocks for nuisance sources of variation then randomize within blocks.
8. Recognize that limited changes of hard-to-change factors affect power and variance estimates, converting a completely randomized design into a split plot design. Be able to build and analyze a first order split plot.
9. Describe the sum of squares decomposition within and between treatments, remember degrees of freedom, means squares and construction of F statistics. Take responses of an experiment and construct ANOVA table (aided by software).
10. Explain normal equations and their solution. Aided by software, with significant model terms, build, interpret and navigate with regression equation.
11. Describe function and construction of residuals.
12. Analyze and interpret graphical residual displays (NPP, residuals vs predicted, residuals vs time, Box-Cox.
13. Describe and apply correct remedy to violations of assumptions.
14. With refined and diagnosed model, be able to predict values and confirm responses to point loci not taken during experiments. Understand navigation with model to optimize one or more responses.
15. Recognize that there are limits to normal theory & least squares in data sets and error distributions.

Grading:

According to the UA instructions for reporting final grades, they generally will reflect the following:

A – (90.0%+)
B – (80.0%+)
C – (70.0%+)
D – (60.0%+)
F – (any grade below 60%)

Grade Breakdown:

Lesson Activities (16 Homework and 16 Quizzes)	20%	320 points
Weekly Discussion Boards (7 Discussion Boards)	10%	160 points
Term Project Assignments (4 project assignments)	10%	160 points
Midterm Exam	20%	320 points
Final Exam	20%	320 points
Term Project Final Submission	20%	320 points
Total	**100%**	**1600 points**

Instructor Feedback and Response:

I generally respond to emails within 24 hours. Grades for assignments are usually available within 72 hours after the due date, but large projects, large classes or complex assignments could take longer.