Ph.D. Qualifying Exam: Statistics and Design of Experiments

Department of Mechanical Engineering University of Utah

Exam Description:

This qualifying exam will test the student's graduate-level knowledge of Statistics and Design of Experiments. Students are expected to understand mathematical concepts and statistical methods used in modern engineering problem solving and analysis. Students should be able to:

- Compute and interpret descriptive statistics using numerical and graphical techniques
- Understand concepts of probability, random variables, and probability distributions
- Compute point estimation of parameters, explain sampling distributions and the central limit theorem
- Develop problem-solving approaches to learning and acquiring information through sampling.
- Understand how redundancy of system components and general system architecture affects system reliability
- Design and analyze single-factor and multiple factor experiments using Analysis of Variance techniques.
- Develop a model with blocking to control for known sources of variation in an experiment
- Derive relationships from Latin Squares and related designs
- Calculate contrasts and understand interaction terms in a linear model
- Perform tests of hypotheses for single and multiple variables
- Communicate results by summarizing and interpreting data

Recommended References:

- D. Montgomery, *Design and Analysis of Experiments*, Wiley Publishing, ISBN-13: 978-1119722106
- D. Barr, D. Diez, M. Cetinkaya-Rundel, *OpenIntro Statistics* (https://www.openintro.org/book/os/)
- G. Oehlert, *A First Course in Design and Analysis of Experiments*, (http://users.stat.umn.edu/~gary/book/fcdae.pdf)
- D. Montgomery, G. Runger, *Applied Statistics and Probability for Engineers*, ISBN-13: 978-1118539712

Exam Materials:

An equation sheet will be provided to students for preparation before the exam. The same sheet will be provided with the exam. Students may bring a department issued calculator. No other materials will be allowed during the exam.

Topics:

The following table provides a list of topics that could be asked on the exam, along with the corresponding sections in the reference textbooks.

Subject	Montgomery	OpenStats
Probability Distributions	Ch 3	Ch 3
Hypothesis Testing and Inference	Ch 3	Ch 4-5
Power and Sample Size	Ch 3	Ch 7
Analysis of Variance (ANOVA)	Ch 4	Ch 7
Complete Randomized Design	Ch 4	
Blocking and Latin Squares	Ch 4-5	
Factorial and Fractional Factorial Designs	Ch 5-7	
Multi-Factor Fractional Factorial Designs	Ch 8-9	
Three-Level Design and Response Surface Methods	Ch 9-11	