ENME392
Statistical Methods for Product and Process Development
Spring 2017

Last updated: March 15, 2017

Course objectives

This course covers the fundamental aspects of probability and statistics. The overall objective is for students to gain an appreciation of the inherent uncertainty and errors in all engineering and scientific data, and to provide the basic tools from probability and statistics to quantify these uncertainties.

Instructors

Johan Larsson (jola@umd.edu). Office hours: Fri 9-11am in EGR3149.
Steve Mitchell (mitchels@umd.edu). Office hours: Thu 3-5pm in EGR2128.

Teaching Assistants and Fellows (TAs and TFs)

Lovlesh Kaushik (lovleshiitr@gmail.com). Office hours: Wed 2-4pm.
Abu Kebbie-Anthony (abkebbieanthony@smcm.edu). Office hours: Thu 5:30-6:30pm.
Xuan Tran (xuantran12@gmail.com). Office hours: Fri 3:30-5:30pm.
Katie Krejcik (kkrejcik@terpmail.umd.edu). Office hours: Wed 12-2pm.

All office hours by TAs/TFs are held in EGR3109.

Lectures

Two lectures per week (Tue/Thu 1100-1215). Lectures are held in JMP3201 for section 0101 and in KEB1110 for section 0201.

The lectures are aimed at explaining the essence of each concept and the general principles. Frequently, the exact equations and formulas and derivations will *not* be covered in lecture; therefore, *it is essential that students read the book for this material.*

Textbook

The textbook for the course is "Statistics for Engineers and Scientists" by Navidi, McGraw-Hill, 4th edition. Every student needs access to the online (Connect) version of this book if they choose to complete the online portion of the homework (this is recommended but not required).

Note that this course is part of the UMD Libraries Top Textbooks on Reserve program, which means that several copies of the book are available at the McKeldin library.

The following books cover all of the material in the course and can therefore be useful as well:
"Applied Statistics and Probability for Engineers", Montgomery and Runger, Wiley.
"Probability and Statistics for Engineers and Scientists", Walpole et al., Prentice Hall.
"Introduction to Probability and Statistics for Engineers and Scientists", Ross, Elsevier.

Course management

Assignments, notifications and supplementary material will be posted on the ELMS Canvas site. Please check this site regularly for updates. Note that the numerical grade computed by ELMS is *not* representative of your actual grade.

Assessment

The course grade will be calculated approximately as:

Participation and dedication	4%
Homework (all kinds)	16%
Exam 1 (in class)	22%
Exam 2 (in class)	22%
Final exam	36%

Teaching philosophy

Based on prior experience, this course presents two major challenges for students:

1. **To connect the abstract math to the real-world common sense understanding.**
   Most students are sufficiently good at math to follow the derivations in this class. And all students already have a common sense understanding of most aspects of probability and statistics. The challenge is to connect those – to be able to see a graph and instinctively visualize what this means, or to see an integral and intuitively understand what that describes.
2. **To choose the right approach to solve a problem.**
   The "mechanics" of solving problems in this course are quite easy, but it can be very tricky to decide what approach (or method) to use. And this choice can hinge on very subtle details in the problem. No matter how much repetitive solving of book problems a student does, the ability to choose the correct problem-solving approach requires an actual understanding of the concepts.

The homework has been designed to address these two major challenges. The online homework is meant to teach the "mechanics" by repetition, while the written homework is meant to stimulate the deeper understanding of the concepts.

Homework

There are 3 kinds of homework in this course, each serving different learning objectives. **Homework assignments 1-10 will be graded**; **LearnSmart and online homework assignments** are provided as opportunities to practice and refine the mechanics of this course, and as such **will not be graded**:

- **LearnSmart reading and quiz.** Before or immediately after we cover a new chunk of material, it is recommended you read the relevant chapter through the LearnSmart feature at the McGraw-Hill website and complete the associated online practice quizzes.
- **Online homework through the McGraw-Hill Connect website.** These questions are provided as opportunities to reinforce new concepts and procedures. You will find these questions relatively straightforward in the sense that the proper approach with which to solve the problem will generally be quite easy to identify.
- **Homework assignments 1-10.** These questions are more convoluted with less guidance on what solution approach to use. You will find these questions more difficult and more representative of the questions on the exams. In fact, almost all pen-and-paper homework problems are old exam problems, which are primarily intend to force students to think beyond the "plug-and-chug" of typical book-problems. The homework problems that require Matlab are intended to help you become comfortable handling large amounts of noisy data (this is often called "Big Data" in fancy circles). You need to write computer code to solve these problems (we use Matlab in this course) and to generate figures.
  Your complete solutions to homework assignments 1-10 must be submitted by uploading a single .pdf file to **Gradescope**. The file should include your complete solutions and boxed

final answers to each question, whatever figures are required, and a print-out of your Matlab code where applicable.

General notes on exams and homework

- The allowable aids during exams are a calculator and a formula sheet. The formula sheet must be created by each student individually, since this is an important part of the learning process. Any statistical tables required will be provided with the exam.
- You must place a box around your final answer. If you change solution approach during the exam, make sure you cross out whatever you do not want to be graded on. If you provide multiple answers, your exam will be graded based on both (where at least one is probably wrong).
- Equations and your thought-process are worth much more than the final answer. Therefore, make sure to show your work even if it is partial. If you know that your answer is wrong, say so very clearly and explain why – this will be worth additional points for the insight shown.
- Make sure to write your name on every page – we frequently tear apart exams during the grading process.

Policy on missing midterm exams

Allowable reasons for missing the midterm exams include sickness (doctor's note required), University-related travel (provided it is of sufficient importance) and religious observances (following the University policy, *students should notify the instructor within the first 2 weeks of the semester*, to allow for adjustments to the scheduling of the midterm exams).

In case of a missed exam, the instructor will either: (a) provide a make-up exam; or (b) adjust the final grade calculation to effectively ignore the missed exam.

Student outcomes

The course contributes to the following ABET outcomes:

(a) an ability to apply knowledge of mathematics, science and engineering;

(b) an ability to design and conduct experiments, as well as to analyze and interpret data;

(e) an ability to identify, formulate and solve engineering problems;

(f) an understanding of professional and ethical responsibility;

(k) an ability to use the techniques, skills and modern engineering tools necessary for engineering practice.

Topics and tentative schedule

1/26: course info; use of statistics in engineering; sample mean and variance.
LearnSmart: 1.1–1.3.

1/31: event, sample space, probability, trees; counting rules, permutations, combinations.
Homework 1.
2/2: Venn diagrams; addition and multiplication rules; conditional probability; Bayes's rule.
LearnSmart: 2.1–2.3.

2/7: random variables, distributions, expected value and variance.
LearnSmart: 2.4–2.5.
Online problems: 2.1–2.5.
2/9: functions of random variables; error-propagation; numerical experimentation.
LearnSmart: 3.1–3.4.
Homework 2.

2/14: functions of many random variables; design-under-uncertainty.
LearnSmart: 4.1–4.2, 4.4.
2/16: normal, binomial, hypergeometric distributions.
LearnSmart: 4.3, 4.5, 4.7.
Online problems: 4.1–4.5, 4.7.
Homework 3.

2/21: Poisson and exponential distributions.
2/23: review and problem solving.
Homework 4.

2/28: review and problem solving.
3/2: **Exam 1**

3/7: sampling, estimators, the Central-Limit theorem.
LearnSmart: 4.9, 4.11.
3/9: confidence intervals (single mean, prediction interval).
LearnSmart: 5.1–5.3.

3/14: cancelled due to snow
3/16: confidence intervals (standard error, T-dist, difference of means); simulation.
LearnSmart: 5.4, 5.6, 5.8.
Online problems: sampling and confidence intervals.

3/28: confidence intervals (paired observations, proportion, variance).
Homework 5.
3/30: concept of hypothesis testing, P-value (single mean, proportion, type I and II errors).
LearnSmart: 6.1–6.4.

4/4: hypothesis testing (variance, two means, pairs).
LearnSmart: 6.5, 6.7–6.8.
Homework 6.

4/6: hypothesis testing (goodness-of-fit, independence).
LearnSmart: 6.11–6.12.
Online problems: hypothesis testing.

4/11: hypothesis testing (goodness-of-fit, independence).
LearnSmart: 6.9–6.10.
Homework 7.
4/13: analysis-of-variance (ANOVA).
LearnSmart: 9.1–9.2.

4/18: review and problem solving.
4/20: **Exam 2**

4/25: analysis-of-variance (ANOVA).
Online problems: ANOVA.
4/27: linear regression.
LearnSmart: 7.1–7.3.
Homework 8.

5/2: multiple linear regression.
LearnSmart: 8.1–8.2.
Online problems: regression.
Homework 9.
5/4: design-of-experiments (DOE).
LearnSmart: 9.3, 9.5.
Online problems: DOE.
Homework 10.

5/9: design-of-experiments (DOE).
5/11: review and problem solving.
