1. **Course number:** GEN_ENG 231

2. **Course Title:** Probability and Statistics for Engineers

3. **Catalog Description, including pre-requisites:**

   Collecting, summarizing and displaying data. An introduction to probability theory and its applications. Conditional probabilities and expected values. Random variables and distributions. Drawing conclusions and making decisions using data: confidence intervals, hypotheses testing, comparison tests, regression, and correlation.

   **Prerequisites:** GEN_ENG 150 or 151, MATH 220-2

**TOPICS**

- The Scientific Method: A Framework for Decision Making
- Data Investigation and Presentation
- Random Variables as Probability Models
- Basic Probability
- Estimation
- Confidence Intervals for Decision Making
- Comparison Decisions
- Linear Regression for Modeling Relationships
- Multiple Regression Models for Prediction

4. **Textbook or other resource materials**

   The Zybooks version of Applied Statistics and Probability for Engineers by Douglas C. Montgomery, George C. Runger, 7th Edition, Wiley, 2019 ISBN: ZY8-1-119-40036-3

5. **Narrative Statements of Learning Objectives**

- Students will be able to use the rules of probability and probability distributions to model the behavior of systems and determine the probability of various events.
- Students will be able to understand and manipulate random variables to determine and their expected value and variance.
- Students will be able to use estimators to construct and use confidence intervals for various parameters, to perform hypothesis tests, and to make engineering decisions.
- Students will be able to design and analyze experiments for comparing the performance of two options using a measurable characteristic.
- Students will be able to use regression to find potential relationships between variables and to model the behavior of systems and predict its outcomes in unobserved states.

## 6. Mapping onto ABET Outcomes

1. *an ability to identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics.* ***major***
2. *an ability to apply engineering design to produce solutions that meet specified needs with consideration of public health, safety, and welfare, as well as global, cultural, social, environmental, and economic factors.* ***minor***
3. *an ability to communicate effectively with a range of audiences.* ***incidental***
4. *an ability to recognize ethical and professional responsibilities in engineering situations and make informed judgments, which must consider the impact of engineering solutions in global, economic, environmental, and societal contexts.* ***minor***
5. *an ability to function effectively on a team whose members together provide leadership, create a collaborative environment, establish goals, plan tasks, and meet objectives.* ***minor***
6. *an ability to develop and conduct appropriate experimentation, analyze and interpret data, and use engineering judgment to draw conclusions.* ***major***
7. *an ability to acquire and apply new knowledge as needed, using appropriate learning strategies.* ***minor***

## 7. Proposed course structure & schedule

*What teaching format do you envision? (Just lectures? Mix of lectures & discussion?).*

***Just lectures with TA office hours and lab/discussion support.***

*How many sections do you anticipate needing, of what size?*

***6-8 sections of 75-100***

*How should these be distributed over the academic year?*

***2 in Fall, 2-3 in Winter, 2-3 in Spring, (maybe 1 in summer)***

*Do you have any plans for any special honors sections?*

***Not planned now, but in a few years, we might create a special section for those with Stats AP and Math AP up to Math 220-2.***

*If so, what would be the qualification metrics, and how would it differ from regular sections?*

***We will decide later.***

**8. Anticipated roster of instructors (2-4 per year)**

*Bruce Ankenman, IEMS*
*Moses Chan, IEMS*
*Jill Wilson, IEMS*
*Suzanne Olds, BME*
*We will likely need 1 or 2 more faculty from other departments starting in year 2. We have started making some inquiries about who these might be.*

**9. Teaching support plan and needs**

Do you envision using graduate TAs, undergraduate Peer Mentors, or both? **Both, we will need 2-3 graduate TAs per section. We are still debating the amount of PM support we will need. Possibly, in-discussion weekly class support. One PM per 15 students, but only once a week for an hour.**

What is the desired ratio of students to TAs or PMs? **See above.**

What would be the duties expected of either TAs or PMs? TAs: **Office hours, grading, and possibly leading the lab/discussion sections with PM support.**

What type of background do you feel is necessary for TAs and/or PMs? **Graduate students with a statistical background for TAs or undergrads who did well in the class for PMs.**

**10. Desired class meeting cadence**

*4 x 1-hour sessions (MTWF), with the Tuesday session available for labs, discussion, additional lectures or reviews.*

**11. Planned assessment strategy & grading rubric**

*Auto-Graded Homework, some TA graded assignments, "On their own" Team Labs with support in the Tuesday session, 2 Midterms, and a Final*

- 30% 2 Midterm Exams
- 10% Auto-graded homework
- 5% attendance
- 15% TA graded homework
- 20% Application Labs
- 20% Final Exam

**12. Weekly listing of course topics**

Week 1
Course Introduction / Syllabus Review
Introduction to Prob/Stat
Data visualization and exploration
Probability axioms
Combinatorics: multiplication rule, gen basic principle of counting

Week 2
Combinatorics: Permutations and Combinations
Introduction to Python: numpy, scipy, matplotlib
Working with data
Conditional probability (with events)
Random variables: definitions, relation to events,
Discrete PMF
Discrete uniform dist.

Week 3
Random variables: CDF, Continuous RVs/pdf, uniform continuous dist.
Probability in Python
Random variables: Bernoulli trials, binomial dist.
Expected value: definition, LOTUS, Linearity

Week 4
Variance: definition, independence, linear combinations
Summary / review
Midterm 1
Expectation and Variance
Normal distribution
Central Limit Theorem
Parameters and estimators
Sampling distribution

Week 5
Sampling
Point and interval estimation
Confidence interval/estimator lab
Prediction interval
Tolerance interval
Decisions with confidence intervals (mu)
Practical importance vs. Statistical significance
(CI, PI, TI) for non-normally distributed data

Week 6
Decisions with confidence intervals (p)
Hypothesis testing with intervals
p-values
How many samples?
Comparison tests: Independent t, paired t-tests and proportions

Week 7
Summary / review
Midterm 2
The regression model
Estimators for regression parameters

Week 8
Predicting with regression
Goodness of Fit (R-squared and correlation)
Regression in Python
Correlation is not Causation
Residual analysis
Hypothesis test for the slope (Beta1)
Regression: practical importance for a slope
Regression: Confidence interval for mean at x0, prediction interval

Week 9
Testing and training
Multiple Regression in Python
Building a regression model
Residual Analysis
Transformations and higher order terms

Week 10
Multiple regression in Python
Best subsets regression
Confidence interval for the mean
Prediction interval lab:
Summary / review

Week 11
Final Exam