Course Description

Uncertainty Analysis in CEE is an undergraduate-level class, which introduces probability and statistics with an emphasis on solving Civil and Environmental engineering (and other) questions, and basic data engineering and data science concepts.

In this course, we will cover the basic concepts of probability such as, marginal probability, joint probability and conditional probability; key statistical concepts, confidence intervals and their interpretation, hypothesis testing procedures, chi-square analysis etc.; basic process for collecting, displaying and analyzing from data; two specific topics, time series analysis and regression methods. In order to present these ideas clear, we will take the application to problems in water resources, climate change, transportation, infrastructure etc. as examples.

The ultimate goal of this course is to thoroughly understand all the material presented and master these basic concepts and procedures. After you study and work
through this course, you should be prepared to participate advanced analytics and
data science courses with a firm understanding of probability, statistics, and data
science.

The primary format of this course will be lectures, hands-on case study,
assignments, a report, two in-class hour exams, and one take-home final exam.

Course Outcomes:
1. Define Random Variables, Sampling, and Mathematical Expectation
2. Compute Joint Probability Distributions, Covariance and Correlation
3. Develop and apply Uniform, Binomial and Hypergeometric, Gamma, Exponential,
   Log-Normal distributions
4. Use Probability paper to analyze Normal and Log-normal random variables
5. Use Chi-Squared Distribution to develop a Goodness-of-fit test; apply Chi-
   Squared and \( F \)-distributions to Sampling Distribution of Variance
6. Apply Central Limit Theorem and \( t \)-Distribution to Sampling Distribution of Mean
7. Estimate Confidence Intervals with known and unknown Population Variance;
   use Prediction Intervals to detect Outliers
8. Use Linear, Non-linear, and Multiple-Regression to model relationships between
   variables
9. Use the Coefficient of Variation (\( R^2 \)) and Model-Parameter Confidence-Intervals
   to find the most Parsimonious Regression Model
10. Postulate Null and Alternative Hypotheses/calculate Type I and II errors; test
    Hypotheses using \( p \)-values
11. Know different data structures; difference supervised learning and unsupervised
    learning; take a hands-on approach to statistical analysis using Jupyter
    Notebooks

Course Outcomes the following ABET program outcomes will be addressed in this
course:
(a) An ability to identify, formulate, and solve complex engineering problems by
    applying principles of engineering, science, and mathematics
(b) An ability to communicate effectively with a range of audiences
(c) An ability to function effectively on a team whose members together provide
    leadership, create a collaborative and inclusive environment, establish goals, plan
    tasks, and meet objectives
(d) An ability to develop and conduct appropriate experimentation, analyze and
    interpret data, and use engineering judgment to draw conclusions
### Tentative Schedule

It is a tentative schedule of lectures and readings for this course. We will try to keep approximately on this schedule.

(Note that we may change the agenda during the fall quarter)

<table>
<thead>
<tr>
<th>Schedule</th>
<th>Mon</th>
<th>Tues</th>
<th>Wed</th>
<th>Fri</th>
<th>Handouts</th>
<th>Hand-ins</th>
<th>Topics</th>
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</thead>
<tbody>
<tr>
<td>Week1</td>
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<td>9.21</td>
<td>9.23</td>
<td>Syllabus HW1</td>
<td></td>
<td>Introduction Review of Critical Probability concepts</td>
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<tr>
<td>Week3</td>
<td>10.3</td>
<td>10.4</td>
<td>10.5</td>
<td>10.7</td>
<td>HW2</td>
<td>HW1</td>
<td>Review of Critical Probability/Statistical concepts</td>
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<tr>
<td>Week4</td>
<td>10.10</td>
<td>10.11</td>
<td>10.12</td>
<td>10.14</td>
<td></td>
<td></td>
<td>Review of Critical Statistical concepts</td>
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<tr>
<td>Week5</td>
<td>10.17</td>
<td>10.18</td>
<td>10.19</td>
<td>10.21</td>
<td>HW3</td>
<td>HW2</td>
<td>Review of Critical Statistical concepts</td>
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<tr>
<td>Week6</td>
<td>10.24</td>
<td>10.25</td>
<td>10.26</td>
<td>10.28</td>
<td>HW3</td>
<td></td>
<td>Correlation Simple Linear Regression</td>
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<td>Week7</td>
<td>10.31</td>
<td>11.1</td>
<td>11.2</td>
<td>11.4</td>
<td>HW4</td>
<td></td>
<td>Multiple Regression</td>
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<tr>
<td>Week8</td>
<td>11.7</td>
<td>11.8</td>
<td>11.9</td>
<td>11.11</td>
<td>HW4</td>
<td></td>
<td>Issues in Regression Analysis</td>
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<tr>
<td>Week9</td>
<td>11.14</td>
<td>11.15</td>
<td>11.16</td>
<td>11.18</td>
<td></td>
<td></td>
<td>Multivariate Analysis</td>
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<tr>
<td>Week10</td>
<td>11.21</td>
<td>11.22</td>
<td>11.21</td>
<td>11.22</td>
<td>No Class</td>
<td>No Class</td>
<td>Time Series Analysis</td>
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<tr>
<td>Week11</td>
<td>11.28</td>
<td>11.29</td>
<td>12.1</td>
<td>12.3</td>
<td>Final Exam Report and Code</td>
<td>Time Series Analysis</td>
<td></td>
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In-Person Instruction

Canvas
We will use Canvas to distribute readings, assignments, and grades.

Zoom
Based on students and instructors’ mutual preference, we may use Zoom to host some office hours or discussion sessions.

Unauthorized student recording of classroom or other academic activities (including advising sessions or office hours) is prohibited. Unauthorized recording is unethical and may also be a violation of University policy and state law. Students requesting the use of assistive technology as an accommodation should contact AccessibleNU. Unauthorized use of classroom recordings — including distributing or posting them — is also prohibited. Under the University’s Copyright Policy, faculty own the copyright to instructional materials — including those resources created specifically for the purposes of instruction, such as syllabi, lectures and lecture notes, and presentations. Students cannot copy, reproduce, display or distribute these materials. Students who engage in unauthorized recording, unauthorized use of a recording or unauthorized distribution of instructional materials will be referred to the appropriate University office for follow-up.

Assignments
We have five homework assignments. These assignments are mainly from the lectures. These assignments will help you understand concepts and ideas you’ve learned from lectures.

Late Assignment Policy: the penalty is **50%** off the grade of your project or each assignment.

Project
We will have a class project for each group which can be self-organized with the approval from the instructor. The size of each group is three at maximum. Each group will be assigned a case with the real data and problems in the real world. Each group also can use existing online datasets or download your own datasets from online resources, like Facebook, Twitter, Yelp, etc. We expect each group could generate a report to show some interesting findings. We encourage each group to use the dataset in their fields.

Grading
Your final grade will be composed from the following items:
**Attendance:** 0.25% * 40 = 10%

Sometimes I will assign some open questions for the next lecture, and you will get something to read or think about it in advance. Please be prepared for a three or five-minute in-class presentation. Depending on the time, I may randomly ask some students to present their findings.

**Assignments:** 10% *4 = 40%
**Project:** 20% *1 = 20%
**Exams:** (15% *1 +15%*1) = 30%

Letter grades are assigned as follows:

<table>
<thead>
<tr>
<th>Points</th>
<th>Letter Grade</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>100 – 90</td>
<td>A</td>
<td></td>
</tr>
<tr>
<td>89 – 85</td>
<td>A-</td>
<td></td>
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<tr>
<td>84 – 80</td>
<td>B+</td>
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<tr>
<td>79 – 75</td>
<td>B</td>
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<tr>
<td>74 – 70</td>
<td>B-</td>
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<tr>
<td>69 – 65</td>
<td>C+</td>
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<tr>
<td>64 – 60</td>
<td>C</td>
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<tr>
<td>Below 60</td>
<td>F</td>
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**Office Hours, E-mail**

Your online office visits are certainly not limited to my regular office hours, but appointments by email preferred for non-regular office hour time. Even my regular office hours, if you could send me an email to confirm that will be great in case I have any other conflicts. Email is a good way to communicate with me since I usually answer messages within one day of receiving them.