Course: ChE 132C  Statistical Methods in Chemical Engineering (Required)

Instructor: Dale E. Seborg, Professor of Chemical Engineering

Catalog Course Description:
Credits: 3 Hours: 3 Lectures per week
Prerequisites: Mathematics 5A-B-C.
Probability concepts and distributions, random variables, error analysis, point estimation and confidence intervals, hypothesis testing, development of empirical chemical engineering models using regression techniques, design of experiments, process monitoring based on statistical quality control techniques.

Texts, References, & Software:
Software: Microsoft Excel

Additional References:

Course Objectives:
1. The overall course objective is to understand basic concepts of probability and statistics and to be able to use them to solve engineering problems.
2. Understand basic techniques for data summary and data presentation.
3. Understand and be able to use basic probability rules and common probability distributions.
4. Be able to estimate population parameters from random samples and perform error analyses.
5. Be able to understand and apply the basic concepts of statistical inference, confidence limits and hypothesis testing.
6. Be able to develop empirical linear models from data and evaluate their statistical properties.
7. Be able to understand and apply the concepts of design of experiments and analysis of variance.
8. Understand the theory and practice of statistical quality control and quality control charts.

Topics Covered (include approximate number of hours for each topic):
Each lecture is 50 minutes long.
<table>
<thead>
<tr>
<th>Lecture #</th>
<th>Topics</th>
</tr>
</thead>
</table>
| 1        | *Chapter 1: The Role of Statistics in Engineering*  
|          | - Sample statistics: mean, median, variance, standard deviation, etc. |
| 2-3      | *Chapter 2: Data Summary and Presentation*  
|          | - Histograms  
|          | - Box plots |
| 4-5      | *Chapter 3: Probability*  
|          | - Sample spaces  
|          | - Probability rules  
|          | - Combinatorial analysis  
|          | - Conditional probability & independence |
| 6-7      | *Chapter 4: Discrete Random Variables and Probability Distributions*  
|          | - Discrete random variables  
|          | - Probability mass functions  
|          | - Cumulative distribution functions  
|          | - Mean and variance of a discrete random variable  
|          | - Uniform, binominal, and Poisson distributions |
| 8-9      | *Chapter 5: Continuous Random Variables and Probability Distributions*  
|          | - Probability density functions  
|          | - Mean and variance of a continuous random variable  
|          | - Uniform and normal distributions  
|          | - Central Limit Theorem |
| 10-11    | *Chapter 6: Joint Probability Distributions*  
|          | - Joint and marginal distribution functions  
|          | - Bivariate normal distribution  
|          | - Linear combinations of random variables  
|          | - Error analysis for nonlinear equations |
| 12-13    | *Chapter 7: Parameter Estimation*  
|          | - Properties of estimators  
|          | - Sampling distributions |
| 14-16    | *Chapter 8: Statistical Inference for a Single Variable*  
|          | - Hypothesis testing  
|          | - Confidence intervals  
|          | - P-values |
| 17-20    | *Chapter 10: Simple Linear Regression and Correlation*  
|          | - Properties of Least Squares Estimators  
|          | - Analysis of variance  
|          | - Hypothesis tests and confidence intervals  
|          | - Assessing model adequacy |
| 21-22    | *Chapter 11: Multiple Linear Regression*  
|          | - Properties of least squares estimation  
|          | - Matrix approach  
|          | - Hypothesis tests and confidence intervals |
### Chapter 13: Design of Experiments with Several Factors
- Two factor factorial experiments
- $2^k$ factorial design

### Chapter 15: Statistical Quality Control
- Quality control charts
- Western Electric rules

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**Laboratory or Other Major Projects:** None

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**The Relation between the Course Objectives and the ChE Program Outcomes**

(Note: SSS = Student Self-evaluation Survey)

<table>
<thead>
<tr>
<th>Course Objectives</th>
<th>Relevant to which ChE Program Outcomes</th>
<th>Course activity</th>
<th>Material to be collected to verify course objective or program outcome</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 P01, P02, P03 P06</td>
<td>Lectures, homework, exams</td>
<td>1. Homework &amp; exams 2. Q1-Q12 on attached SSS</td>
<td></td>
</tr>
<tr>
<td>2 P01, P05</td>
<td>Lectures, homework, exams</td>
<td>1. Homework &amp; exams 2. Q1 &amp; Q2 on attached SSS</td>
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<tr>
<td>3 P01</td>
<td>Lectures, homework, exams</td>
<td>1. Homework &amp; exams 2. Q3-Q6 on attached SSS</td>
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<tr>
<td>4 P01, P02, P03</td>
<td>Lectures, homework, exams</td>
<td>1. Homework &amp; exams 2. Q7 on attached SSS</td>
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<tr>
<td>5 P01, P02</td>
<td>Lectures, homework, exams</td>
<td>1. Homework &amp; exams 2. Q8 on attached SSS</td>
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<tr>
<td>6 P01, P02, P03 P06</td>
<td>Lectures, homework, exams</td>
<td>1. Homework &amp; exams 2. Q9 &amp; Q10 on attached SSS</td>
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<tr>
<td>7 P01, P02, P03</td>
<td>Lectures, homework, exams</td>
<td>1. Homework &amp; exams 2. Q11 on attached SSS</td>
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<tr>
<td>8 P01, P02, P03 P06</td>
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<td>1. Homework &amp; exams 2. Q12 on attached SSS</td>
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**Chemical Engineering Department Program Outcomes:**

Upon graduation, graduates of the ChE program at UCSB are expected to have:

**PO1. [Fundamentals]** the fundamental knowledge of mathematics, computing, science, and engineering needed to practice chemical engineering and the ability to apply this knowledge to identify, formulate, and solve chemical engineering problems.

**PO2. [Laboratory]** the ability to design and conduct experiments and to analyze and interpret data.
PO3. **[Design]** the ability to design a system, component, or process to meet desired specifications. Ability to use modern engineering tools necessary for chemical engineering practice.

PO4. **[Advanced Training]** beyond the basic fundamentals in at least one area of chemical engineering as preparation for a continuing process of lifelong learning (i);.

PO5. **[Teamwork/Communication]** the ability to function productively in multidisciplinary teams working towards common goals; the ability to communicate effectively through written reports and oral presentations.

PO6. **[Engineering & Society]** the broad education necessary to understand the impact of engineering solutions in a global/societal context; a knowledge of contemporary issues; an understanding of professional and ethical responsibility; a recognition of the need for and the ability to engage in lifelong learning.