COURSE OUTLINE
MECH 351 – DESIGN OF EXPERIMENTS

Prepared By: Michael J. Newtown, P.E.
Updated By: Daniel Miller (April 2015)
A. **TITLE**: Design of Experiments

B. **COURSE NUMBER**: MECH 351

C. **CREDIT HOURS**: 3

D. **WRITING INTENSIVE COURSE**: No

E. **COURSE LENGTH**: 15 weeks

F. **SEMESTER(S) OFFERED**: Fall or Spring

G. **HOURS OF LECTURE, LABORATORY, RECITATION, TUTORIAL, ACTIVITY**: 3 lecture hours per week

H. **CATALOG DESCRIPTION**: This course provides methodologies that engineers, technologists, and management personnel need to plan and conduct experiments to quantify cause and effects relationships in complex systems. Design of experiments test multiple factors at one time determining whether changes to products, processes, and systems are improvements. Students will perform simple comparative experiments isolating known sources of variation; while multiple level fractional designs will allow analysis of variance (ANOVA) to predict models of interactions that optimize a process.

I. **PRE-REQUISITES/CO-COURSES**: Junior level status

J. **GOALS (STUDENT LEARNING OUTCOMES)**: By the end of this course, the student will be able to:

<table>
<thead>
<tr>
<th>Course Objective</th>
<th>Institutional SLO</th>
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<tbody>
<tr>
<td>1. Explain why changing single factors one at a time leads to tampering with the system.</td>
<td>1. Communication</td>
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<td>2. Employ statistics to isolate known sources of variation.</td>
<td>2. Critical Thinking</td>
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<td>3. Calculate and interpret ANOVA</td>
<td>3. Professional Competence</td>
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<td>4. Create and evaluate cube plots of experimental results.</td>
<td>2. Critical Thinking</td>
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<td>5. Define terminology of Design of Experiments</td>
<td>1. Communication</td>
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<td>6. Interpret descriptive statistics and question reliability of data</td>
<td>2. Critical Thinking</td>
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<td>Activity</td>
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<td>7.</td>
<td>Formulate null and alternative hypothesis to define experiments</td>
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<td>8.</td>
<td>Compare and contrast type I and type II error.</td>
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<td>9.</td>
<td>Discuss and evaluate confidence intervals of experiments</td>
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<td>10.</td>
<td>Create randomized experiments and identify the interactions and confounding patterns.</td>
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<td>11.</td>
<td>Choose factorial designs that provide the best experimental results.</td>
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<td>12.</td>
<td>Compare and contrast classical DOE with the Taguchi Method.</td>
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</table>


**L. REFERENCES:**  
Cornell, John, Experiments with Mixtures, 2nd ed. 1990, John Wiley and Sons.  
John, Peter, Statistical Design and Analysis of Experiments, 1969, Macmillan Company  

**M. EQUIPMENT:** Technology enhanced classroom  

**N. GRADING METHOD:** A-F  

**O. MEASUREMENT CRITERIA:** Tests, Quizzes, Homework, Project, and Oral Presentation  

**P. DETAILED TOPICAL OUTLINE:** Attached  

**Q. LABORATORY OUTLINE:** N/A
DETAILED OUTLINE
MECH 351 – DESIGN OF EXPERIMENTS

TOPICS

I. Introduction to Design of Experiments
   A. Process improvement
   B. Descriptive statistics
   C. Confidence Intervals
   D. Model for improvement

II. Simple Comparative Experiments
   A. F-tests
   B. Fair testing
   C. Blocking known variation

III. Testing of Single Factors
   A. Principles for testing
   B. Two-level, one factorial design
   C. Plots and interpretation of interactions
   D. Modeling responses w/ predictive equations

IV. Testing of Multiple Factors
   A. Principles for testing
   B. Two-level, multiple factorial design
   C. Plots and interpretation of interactions
   D. Modeling responses w/ predictive equations

V. Response Transformation
   A. Mathematical transformations
   B. Choosing the right transformations

VI. Fractional Factorials
   A. Examples of fractional factorials
   B. Potential confusion by aliasing
   C. Plackett-Burman design
   D. Taguchi design
   E. Irregular fractions

VII. Minimal-run designs
    A. Resolution of minimal-runs
    B. Fold-over of resolution III designs
    C. Single factor fold-over

VIII. General Factorial Designs
    A. Analyze un-replicated general factorials
B. Optimizing response surface models
C. Augmenting a central composite design
D. Mixing designs