ISE 525 DESIGN OF EXPERIMENTS
FALL 2013

ISE 525 Design of Experiments
Fall 2014
MW 11:00-12:20pm
Room: OHE 100D
Web site: www.uscden.net

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PREREQUISITE: ISE 225 Engineering Statistics I (or equivalent)

COURSE OBJECTIVE: This course will present the principles and methods of statistical design of experiments.

TEXT: Wu & Hamada, *Experiments: Planning, Analysis and Optimization*, 2009, John Wiley, ***Second edition***. All data sets and errata in the book can be downloaded from
http://www2.isye.gatech.edu/~jeffwu/book/

SOFTWARE: Using statistical software is mandatory in your class project and some of your homework assignments. At your convenience, you could choose R, Minitab, Matlab, or Excel. A powerful statistical software R, which is free for download at www.r-project.org, will be demonstrated for problem solving in the class. PhD students are strongly recommended to use R.

TA & OFFICE HOURS: TBD

TENTATIVE TOPICS:

1. *Basic principles and introduction to regression analysis (Chapter 1)*
   - Lecture 1: Introduction of course policy, DOE & brief introduction of ***R***
   - Lecture 2: Introduction of ***R***, example of using ***R*** to fit a linear model
   - Lecture 3: ***R*** reference card, introduction of linear model and simple linear regression. Show examples of hand calculation.
   - Lecture 4: Brief review of variance, hypothesis testing, *t*-test and confidence interval, and Multiple regression. Show examples of hand calculation.
   - Lecture 5: Multiple regression, *F* test, examples of using ***R***. Show examples of hand calculation. (**HW#1**)

2. *Experiments with a single factor, analysis of variance (Chapter 2)*
   - Lecture 6: One-way ANOVA (introduction, ANOVA decomposition)
   - Lecture 7: One-way ANOVA (Multiple comparison, Linear quadratic effects, residual analysis). Show two examples of doing ANOVA by ***R***. (**HW#2**)

3. *Experiments with more than one factor (Chapter 3)*
   - Lecture 8: Paired comparison & randomized block design
   - Lecture 9: Two-way layout, Latin square design, balanced incomplete block designs, using ***R*** to do analysis (**HW#3**)

4. *Full factorial experiments at two levels (Chapter 4)*
   - Lecture 10, Transformation of response, factorial design at two levels
   - Lecture 11: Factorial effects and plots, effect estimation, regression model, half-normal plot, two-step procedure
   - Lecture 12: Show examples of using ***R*** to compute factorial effects, to plot half-normal and interaction plots. Design of 2^k factorial experiments in 2^q blocks, ANOVA vs. factorial designs (**HW#4**)

5. *Fractional factorial experiments at two levels (Chapter 5)*
   - Lecture 13: Effect aliasing, resolution, and minimum aberration
   - Lecture 14: Analysis of fractional factorial experiments, follow-up experiments
   - Lecture 15: Design of 2^{k-p} fractional factorial design, blocking effects (**HW#5**)

6. *Factorial experiments at three levels (Chapter 6)*
   - Lecture 16: Two-step procedure, 3^k full factorial designs, orthogonal component decomposition
   - Lecture 17: 3^{k-p} fractional factorial designs, defining relation, aliasing groups, minimum aberration
   - Lecture 18: Simple analysis methods, linear-quadratic decomposition, variable selection

7. *Response Surface methodology (Chapter 10)*
   - Lecture 19: Introduction to response modeling (sequential principles), steepest ascent search (**HW#6**)
   - Lecture 20: Curvature check, central composite designs

8. *Robust parameter design for product and process improvement (Chapter 11&12)*
   - Lecture 21: Robust parameter design perspective, noise factors, control-by-noise interaction
   - Lecture 22: Experimentation strategies (cross array vs. single array), modeling strategies (location and dispersion modeling vs. response modeling), Taguchi's signal-to-noise ratio

GRADING POLICY

Homework: 30%
Midterm exam on **Wednesday, Oct. 15th, 2014** (in class): 30%
Final exam on **Wednesday, Dec 10th, 2014** (11-1pm): 30%
Class project: 10%

Project proposal and final project will be presented in class. Den students could involve by upload to video to blackboard.

SAMPLE CLASS PROJECT

- **Example one on 3D printing experiments**: Optimization of surface roughness for Fused Deposition Modeling: Fused Deposition Modeling (FDM) is a popular 3D printing process to produce 3D objects directly from CAD models. One drawback of FDM is the seam lines between layers will impact on the surface roughness of printed parts. The team selects the lifting gap of extrusion head in the vertical direction, speed of extrusion head in the horizontal direction, heating temperature of the nozzle orifice, feeding speed of materials and environment humidity as experimental factors. The team will identify the significant factors and the optimal settings to minimize surface roughness.

- **Example two on the energetic feeling** and its relation with coffee and other factors: The team investigates factors of sleep quality, workload, and drinking coffee and their impact on the energetic feeling.
- **Example three on microwave popcorn experiments:** The team aims to find the significant factors and their settings (recipe) to make popcorns.

CLASS POLICY

- For **on-campus** students, assigned homework will be collected **in class**. Homework is due one week after it was assigned. For **DEN** students, make sure to email/fax the homework to DEN office on the due date. ***No late homework will be accepted in general.***
- Midterm exam can be taken on or before the scheduled exam date.
- Per instructions of USC final examinations schedule (http://classes.usc.edu/term-20143/finals/), DOE ***final exam*** can only be given on **Dec 10th, 2014**.
- Both exams will be closed book, closed notes. One page (8 ½ x 11) formula sheet can be used. Be sure to bring your calculator. There will be ABSOLUTELY NO SHARING among students of books, formula sheets, or calculators.
- Please show steps in your work in order to gain partial or full credits.
- If you believe there was an error in the grading of an exam, then you can submit the entire exam to the instructor requesting to re-grade. This must be done ***within one week*** from the date the exam was returned. The entire exam will be re-graded, so that you may gain, or lose, points by resubmitting.
- During class time, please ***turn off*** all cell phones, beepers and pagers.
- Students are responsible for all information conveyed during class and on Blackboard (www.uscden.net). It is the student's responsibility to make sure they are receiving their emails related to the class.
- Always bring your textbook to class! Also bring your calculator, notebook, pencils/pens, eraser, and course syllabus.
- If there is any discrepancy between class policy and DEN or USC policy, we will follow DEN/USC policy.

PROJECT GUIDELINE

The object of the project is to learn how to properly apply DOE methodologies to engineering problems. Two or three students work in a team on one of the assigned project problems.

ACADEMIC INTEGRITY: The Department of Industrial and Systems Engineering adheres to the University's policies and procedures governing academic integrity as described in SCampus. Students are expected to be aware of and to observe the academic integrity standards described in SCampus. Students should expect those standards to be enforced in this course.

ACCOMMONDATIONS FOR DISABILITIES: Any student requesting academic accommodations based on a disability is required to register with Disability Services and Programs (DSP) each semester. A letter of verification for approved accommodations can be obtained from DSP. Please be sure the letter is delivered to the instructor as early in the semester as possible. DSP is located in STU 301 and is open 8:30 am - 5:00 pm, Monday through Friday. The phone number for DSP is (213) 740-0776.