King Fahd University of Petroleum & Minerals
MECHANICAL ENGINEERING DEPARTMENT
ME 451: Design and Analysis of Engineering Experiments

Catalogue Description: (3-0-3)
The course deals with basic statistics, design of experiments, uncertainty and error analysis general characteristics of measurement systems, statistical analysis of experimental data, empirical modeling, experimental uncertainty analysis, as well as guidelines for planning and documenting experiments. Illustrative examples from industry and case studies of planned engineering experiments.

Status in Curriculum (Required or Elective): Required (offered Fall & Spring)

Prerequisites: EE 204, ME 307, ME 315

Co-requisites: ME 452

Textbook:"Design and Analysis of Experiments" (International Student Version), Montgomery, Douglas C., 8th edition, 2012, John Wiley & Sons

References:
1) "Engineering Statistics" by Montgomery, Douglas C., Runger, George C. and Hubele, Norma F., 5th edition, 2012, ISBN-13: 978-1-118-09793-9 - John Wiley & Sons
2) "Experimental Methods for Engineers" by Holman, J. P., McGraw Hill, 2011.
3) "Applied Statistics and Probability for Engineers" by D. C. Montgomery and G. C. Runger, 5th Edition, John Wiley & Sons, Inc. 2011
4) "Design and Analysis of Experiments" by Angela Dean and Daniel Voss, 1999.

Coordinator:Dr. S. Sohail Akhtar, Assistant Professor in Mechanical Engineering

Goals:(general objectives)
This course is primarily designed for majors in Mechanical Engineering at the undergraduate level; however, it is appropriate for science and engineering students with background in statistics and interested in the characterization and improvement of manufacturing and services processes through experimentation. The purpose of the course is to prepare students for: i) mastering the theoretical and applied framework needed to effectively design, conduct, and analyze experiments in the general engineering field and ii) conducting estimable research in the experimental design area. Opportunities to use the principles taught in the course arise in all phases of engineering work, including new product design and development, process development, and manufacturing process improvement. Computer software packages (SAS, StatGraphics etc.) to implement the methods presented will be illustrated extensively, and the students will have opportunities to use it for homework assignments and the term project.

Course Outline (Lecture Topics):
1. Introduction to statistics: *descriptive statistics including data summary and* presentation (2 hours)
2. Random variables and probability distributions: (5 hours)
3. Distributions of sampling statistics: (3 hours)
4. Hypothesis testing and decision making for single and multiple samples:(7 hours)
5. Regression/building empirical models: (5 hours)
6. Analysis of Variance (ANOVA): (4 hours)
7. Introduction to uncertainty and error analysis of experimental data causes and types of experimental errors. (2 hours)
8. More about ANOVA: *Multiple comparisons, residuals and model adequacy checking, checking model assumptions, the Box-Cox method* (3 hours)
9. Choice of sample size in designed experiments: (2 hours)
10. Factorial Designs: *Introduction to factorial designs, 2^k factorial designs, Residual analysis and model checking, blocking and confounding in two level factorial designs, case studies.* (7 hours)
11. Two-Level Fractional Factorial Designs: *Introduction, The One-Half Fraction of the 2^k design, case studies.* (4 hours)

Design Activities/Projects:

Students will be introduced to the fundamental concepts of statistics and design of experiments. Students will learn how to analyze and design engineering experiments. Term projects and case studies are designed to promote and strengthen teamwork to produce a formal report and enhance communication skills through oral

and poster presentation of their projects.

Computer Usage:

Most of the data analysis and related homework/case studies will require the use of any of the major statistics and DOE packages for this course. Suitable packages include but are not limited to SAS, SPSS, Statistica, StatGraphics, and DOE

Assessment Tools:

i- Mid-term Examinations
ii- Homework Assignments/Projects
iii- Quizzes
iv- Final Exam

Course Learning Outcomes:

Upon completion of the course:

1. The student should understand the statistical basis of analysis of variance.
2. The student should understand the basic concepts of design of experiments.
3. The student should demonstrate the ability to understand different types of experimental design.
4. The student should demonstrate the ability to design experiments and analyze the data for real problems.
5. The student should learn how to use computer software to analyze experimental data. They will also be able to use the techniques, skills, and modern engineering tools necessary for engineering practice, through the use of library, internet, computer programs and word processors.
6. The student must apply the fundamental concepts of design and analysis of experiments to a practical application. This application should involve the definition of the problem under study, the actual design of experiment, data collection, data analysis, uncertainty and error analysis, the validation of the results and conclusions and recommendations
7. Students should be able to work and write reports together as team members and communicate more efficiently through oral/poster presentation.
8. The students will be able to understand professional responsibility through data collection procedures, review of statistical and DOE issues, and public relations and contemporary issues associated with them.

Course Learning Outcomes mapped to Student Outcomes*:*

Student Outcomes	*a*	*b*	*c*	*d*	*e*	*f*	*g*	*h*	*i*	*j*	*k*
Course-to-Student outcome mapping	1, 2, 3, 4, 5, 6, 8	1, 2, 3, 4, 5, 6, 8		5, 6, 7, 8	1, 2, 3, 4, 5, 6, 8	6, 7, 8	5, 7,	7, 8	5, 6, 7, 8		3, 4, 5
Emphasis*	S	S		M	S	M	L	L	M		M

L: Little/None **M**: Moderate **S**: Strong

Status of Continuous Improvement review of this Course:

Date reviewed: ---------- **Reviewed by:** Dr. M. Abdul Samad and Dr. A. K. Sheikh
Prepared by: Dr. S. Sohail Akhtar **Date prepared:** Sept 25, 2012