University of Puerto Rico. Mayagüez Campus
College of Engineering.
Industrial Engineering Department

Course Syllabus

General Information

Course Number: InIn 6005
Course Title: **Experimental Statistics**
Credit-Hours: Three

Course Description

Applications of multiple regression to analysis of variance and experimental designs. Analysis of multiple experimental design involving fixed, random, and mixed effects; including crossed and nested, and mixture design. Applications of screening techniques for more than 10 factors. Emphasis on computer model applications.

Prerequisites

Authorization of the Director of the Department

Textbook and References

- Montgomery, D. C., 2013, Design and Analysis of Experiments, 8th Edition, John Wiley and Sons.
- Box, G. E. P., Hunter, J.S., and Hunter, W. G., 2005, Statistics For Experiments, 2nd Edition, John Wiley and Sons.
- Hicks, C. R., and Turner, K.V., 1999, Fundamental Concepts in The Design of Experiments, 5th Edition, Oxford University Press.
- Myers, R. H., and Montgomery, D. C., 2002, Response Surface Methodology: Process and Product Optimization Using Designed Experiments, 2nd Edition, John Wiley and Sons.
- Anderson & McLean, 1984, Design of Experiments, a Realistic Approach. Marcel Dekker, New York.

Purpose

This course is primarily designed for majors in Industrial Engineering (IE) at the graduate 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 meritorious research in the experimental design area. The use of statistical software packages is strongly emphasized for the planning and analysis phases of experimentation. This course is a requisite in the MEMSE and MSIE.

Course Goals

- The student should understand the statistical basis of analysis of variance.
- The student should understand the basic concepts of design of experiments such as randomization, confounding, and blocking.
- The student should master basic designs in experimentation.

- The student should be able to apply statistical experimentation to reduce variability and tune means on target values.
- The student should learn how to use computer software to analyze experimental data (Design Expert, Minitab, etc.)
- The student should acquire a working knowledge of response surface methods. 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, the determination of the significative factors and their optimum levels, the validation of the results and conclusions and recommendations. Applications that involve concepts from another areas (such as quality control, reliability, human factors) are encouraged.

Requirements

All students are expected to come to class on time, and prepared; do all assigned readings and related homework; actively participate in class discussions; and satisfy all assessment criteria to receive credit for the course.

Department and Campus Policies

Class attendance: Class attendance is compulsory. The University of Puerto Rico, Mayagüez Campus, reserves the right to deal at any time with individual cases of non-attendance. Professors are expected to record the absences of their students. Frequent absences affect the final grade, and may even result in total loss of credits. Arranging to make up work missed because of legitimate class absence is the responsibility of the student. (Bulletin of Information Undergraduate Studies)

Absence from examinations: Students are required to attend all examinations. If a student is absent from an examination for a justifiable reason acceptable to the professor, he or she will be given a special examination. Otherwise, he or she will receive a grade of zero of "F" in the examination missed. (Bulletin of Information Undergraduate Studies)

Final examinations: Final written examinations must be given in all courses unless, in the judgment of the Dean, the nature of the subject makes it impracticable. Final examinations scheduled by arrangements must be given during the examination period prescribed in the Academic Calendar, including Saturdays. (see Bulletin of Information Undergraduate Studies).

Partial withdrawals: A student may withdraw from individual courses at any time during the term, but before the deadline established in the University Academic Calendar. (see Bulletin of Information Undergraduate Studies).

Complete withdrawals: A student may completely withdraw from the University of Puerto Rico, Mayagüez Campus, at any time up to the last day of classes. (see Bulletin of Information Undergraduate Studies).

Disabilities: All the reasonable accommodations according to the Americans with Disability Act (ADA) Law will be coordinated with the Dean of Students and in accordance with the particular needs of the student.

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Ethics: Any academic fraud is subject to the disciplinary sanctions described in article 14 and 16 of the revised General Student Bylaws of the University of Puerto Rico contained in Certification 018-1997-98 of the Board of Trustees. The professor will follow the norms established in articles 1-5 of the Bylaws.

General Topics

Lecture	Topic	Reading
1	Introduction	1,2
2	Basic Definition in experimental design: factor, levels, responses, treatments, randomization, blocking...	3.1, 3.2
3-4	Experiments with a single factor (fixed model) Cochran's theorem and ANOVA	3.3
5	Comparison of individual treatment, LSD.	3.5
6	Model Adequacy Checking. Bartlett's test and Transformations	3.4, 3.5
7-8	Choice of Sample Size. Kruskal-Wallis Test.	3.7, 3.11
9-10	The regression approach to ANOVA.	3.10
11-13	Randomized Complete Block Design. The Latin Square Design. The Greco-Latin Square Design. Estimating model parameters and the general regression significance test	4
14-16	Factorial design, advantages, definitions, fitting models, choices sample size. Two factor and general factorial design. Fitting a response surface	5.1, 5.2, 5.3,5.4 5.5
17-19	The 2^k factorial designs. 2^3 design, single replication. Advantages of using coded variables	6.1, 6.3, 6.4, 6.5, 6.6, 6.9
20-22	Confounding in the 2^k factorial. Partial confounding.	7
23-25	Two-level fractional factorial designs. Yates's algorithm, Alias structure, resolution, super saturated design for factorial screening (Plackett-Burman, 2_{III}^{k-p} fractional factorial, and Taguchi' method)	8
26-28	The 3^k factorial designs, blocking and fractional designs.	9.1,9.2, 9.3
29-30	Random and mixed models. Expected means squares. Approximate F test.	13.1, 13.2, 13.3, 13.5, 13.6
30-31	Two-stage nested design. Factorial with block design	14.1, 14.3 5.6
32	The split-plot design.	14.4
33	Introduction to Response Surface Methods.	11.1
34	The method of steepest ascent.	11.2
35-36	Analysis of a second order model.	11.3
37	Multiple responses	11.3.3
38-39	Experimental designs for fitting response surfaces- Central composite design (CCD), and spherical CCD Box - Behnken	11.4

	design. Variance rotability, variance dispersion graph, and optimal design.	
39-40	Mixture Experiments	11.6

*All readings from Montgomery, 2005.

Revised by NDR feb-2017