NATIONAL UNIVERSITY OF ENGINEERING
COLLEGE OF ECONOMICS AND STATISTICAL ENGINEERING

STATISTICAL ENGINEERING PROGRAM

ES713 – DESIGN AND ANALYSIS OF EXPERIMENTS

I. GENERAL INFORMATION

CODE	**:**	ES713 Design and analysis of experiments
SEMESTER	**:**	7
CREDITS	**:**	4
HOURS PER WEEK	**:**	7 (2 Theory – 3 Practice – 2 Laboratory)
PREREQUISITES	**:**	ES612 Linear Modeling
CONDITION	:	Mandatory

II. COURSE DESCRIPTION

In all productive industrial sectors, the effective use of experimental design is the key to achieve high yields, reduce variability, reduce delivery times, improve products, reduce product development times and have more satisfied customers.
Experimental designs are a set of active techniques that manipulate the process to induce it to provide what is required to improve it. These statistical and engineering techniques allow maximum efficiency in production processes at the lowest cost. Nowadays, continuous improvement, as a tool included in the production processes, responds to the demands of customers and consumers, being necessary to comply not only with the standards, but also the demands and expectations of the customers.

III. COURSE OUTCOMES.

1. Understand the methodology of the design of experiments that allows to understand and improve industrial processes by means of the planned search of the factors that affect the variables that best represent the process.
2. Learn to discriminate, select and validate the most appropriate experimental design model. In such a way that it will allow to develop, with rigor and clarity, the statistical analysis of the main models of experimental design. In addition, acquire the necessary training to interpret the results obtained by means of the statistical analysis of the data from a point of view of statistical significance and practical significance.
3. To master the general functioning of some statistical software, such as SAS 9.0, in particular, the modules referred to the Design and Analysis of Experiments..

IV. LEARNING UNITS

1. Experimental design: Objectives and basic principles: Factor, Level of a factor, Variable and experimental unit, Statistical data and Treatment. Statistical experiment. Basic concepts and types, General guidelines for the design of experiments.
   Distribution of treatments in the experimental field: Full random distribution, Distribution in blocks, Latin square, Distribution in modified Latin square. Analysis of Variance: Analysis of the model with fixed effects, Unbalanced data.

2. Comparison of treatments: Planning of comparison between treatments, Curves of response for factors of quantitative treatments, multiple comparisons. Diagnosis of

the concordance between the data and the model: Transformations stabilizing the variance evaluation of models: Integrator example.

3. Effective experiments with factorial designs: Factor effects, Statistical model and analysis for two factors, Use of response curves for quantitative treatment factors, Random and mixed models.

4. Model with random effects to study variances. How many observations to study variances, random sub samples to gather data for the experiment.
   Statistical model for components of variance, point estimate, interval estimation for variance components.

5. Study of a 2^k design. Yacht algorithm, Rules for the sum of squares and expected average squares. Case 2^5, Collapsing Designs 2^k.

6. Confusion techniques in factorial experiments: Confused technique, Confused in a 2^k factorial design, partial confounding technique, Confused in a 3^k factorial design. 3^K: Approach to optimization models.

7. Aggregation of central points, composition of designs, designs with a single replica. Real case studies in industrial sectors. Designs of divided parcels. Designs of nested, crossed and nested cross-factors.

8. Design with double subdivision of parcels for three treatment factors. Experiments in series.

9. Design with repeated measurements. Analysis of covariance.

10. Introduction. Preliminary concepts, ½ fraction of a 2^k design. Case Study Fraction ¼ of a 2^k design. Integrator example. Factorial Designs 2^{k-p}.

11. Special Cases in the Energy Industry: Design by Plackket and Burman. Methods of ascending slope, Simple search method. Rotatable designs: Pentagonal design, hexagonal design, octagonal design.

12. Mix Designs: Design of mixes without restrictions. Design of mixtures with restrictions. Alternative models. Problems involving mix designs.

13. Composite designs: Estimation of mathematical models for rotable and composite designs, Analysis of variance for rotable and composite designs, analysis of maxima and minima. Optimal solutions: With and without restrictions. Box and Benkhen design.

V. GRADING SYSTEM

We apply a mixed evaluation system, which includes: Work carried out throughout the course (participation in theoretical and practical classes, etc.); Written test; Tests to evaluate computer practices (theoretical development of an experimental design model together with its practical application to a specific case).

VI. BIBLIOGRAPHY

1. Robert O Kuel (2001). Design of experiments. Thomson Publishing Group.
2. Montgomery, DC (2001). Design and analysis of experiments. Editorial Group Iberoamericana.
3. Box, G.E.P; Hunter, W.G; Hunter, J, S (1989). Statistics for researchers.
4. Cochran, W.G. And Cox, G.M. (nineteen ninety five). Experimental Designs. Trillas, Mexico.

5. Peña Sánchez de Rivera, D. (2000). Statistics, Models and Methods. Volume II: Linear Models.
6. Martínez, A. (1988). Experimental Designs. Methods and Elements of Theory. Editorial Trillas, Mexico.
7. Joan Valls, Llorenc Badiella, Servei d 'Statistics UAB. Introduction to SAS. Autonomous University of Barcelona.
8. Llorenc Badiella Busquets, Anna Espinal Berenguer. Statistical and Programming Practices in SAS.