PERSONA CIÈNCIA EMPRESA
UNIVERSITAT RAMON LLULL

COURSE: EXPERIMENTAL DESIGN

SUBJECT: Experimental Design
MODULE: M1. Process Engineering and Product Module
PROGRAME: M1. Process Engineering and

GENERAL FEATURES *

Type: ☑ Elective

Duration: Semester **Semester / s:** 1

Number of ECTS credits: 3

Language / s: Spanish, English

DESCRIPTION

BRIEF DESCRIPTION AND JUSTIFICATION (The meaning of the course in relation to the program. Between 100 and 200 words.)

Presentation of tools and basic strategies for experimental planning.

Special emphasis is placed on the techniques derived from the Taguchi® method and the obtaining of optimal experimental designs.

Strategies involving response surface methodology for sequential optimization are introduced.

COMPETENCES (Of the course in relation with preassigned competences in this area.)

- The student has knowledge and understanding of what constitutes a basis or an opportunity to be original by developing and/or applying ideas, often in a research context (CB6).
- The student can apply their knowledge and their ability to solve problems in new or unfamiliar environments within broader (or multidisciplinary) contexts related to his/her field of study (CB7).
- The student has the ability to solve problems that are unfamiliar, incompletely defined, and have contradictory specifications, considering the possible methods of solution, including the most innovative, selecting the most appropriate, being able to correct implementation and evaluating the different design solutions (CE4).

PREREQUISITES * (Modules, materials, subjects or skills necessary to follow the course. Subjects can be stated that should have been completed.)

The corresponding to access master studies.

* These features should not be modified without the approval of the bodies responsible for academic higher-level structures (field, module and / or system).

CONTENTS (Sections that make up the syllabus, to a second level of detail.)

1. Introduction to design of experiments.
   What is the objective. Two common strategies. Basic concepts. Work scheme. For a few dollars more...

2. Factorial designs.
   Full factorial designs. The full factorial design 2^2. The full factorial design 2^f. Fractional factorial designs. The fractional factorial design 2^{3-1}. The fractional factorial design 2^{f-p}. Saturated designs. Sequentiality. Summary. Study of cases.

3. Taguchi method (fundamentals).
   The concept of robustness. Planning experiences: Taguchi's approach. Orthogonal arrays. Linear graphs and interaction tables. Allocating factors to the matrix. Analysis: parameter design. Study of cases.

4. Taguchi method (special designs).
   Introduction: advantages and disadvantages of Taguchi methodology, special designs. Column-merging method. Idle-column method. Dummy-level technique. Combination design. Application of techniques. Study of cases. Comparing Taguchi method and classic methodology.

5. Response surface methodology.
   Motivation. The model expression, estimation and validation. Designs: Introduction. Factorial designs 3^f. Central composite designs. Doehlert designs. The choice of design. Case analysis. MSR application in sequential optimization.

METHODOLOGY

LEARNING ACTIVITIES * (Complete the table relating activities, workload in ECTS credits and skills.)

Learning Activities	**ECTS Credits**	**Competences**
Sessions of exposition of concepts	0.7	CB6, CB7, CE4
Sessions solving exercises, problems and cases	0.3	CB6, CB7, CE4
Seminars	0.3	CB6, CB7, CE4
Presentations	0.1	CB6, CB7, CE4
Activities of personal study by students	1.5	CB6, CB7, CE4
Evaluation activities (testing, monitoring controls ...)	0.1	CB6, CB7, CE4
TOTAL	**3**	

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TEACHING METHODOLOGY (Justifying the teaching methods used in relation to the competences and contents of the course. Between 100 and 200 words.)

Part of the course is dedicated to exposing the fundamentals and techniques of experimental design through lectures (sessions exhibition concepts). The remaining time, sandwiched between the keynote sessions, is dedicated to the resolution, discussion and debate of numerous case studies (case solving, seminars). IT tools are incorporated to streamline the calculations and interpretation and presentation of results. Therefore, students in class must have a laptop with Microsoft Excel installed. Some complex macros are supplied.

Some of the cases studied in class must be submitted for assessment, which should be complemented by hours of work outside the classroom (personal study). In class the results are presented and discussed (presentation).

Throughout the course follow-up tests at the end of each of the chapters are made. Upon completion of a final exam (evaluation) is performed.

The Moodle platform for students have the basic and supplementary subject material is used, and to establish two-way communication.

ASSESSMENT

ASSESSMENT METHODS * (Complete the table relating evaluation methods, competences and weight in the qualification of the subject.)

Evaluation Methods	**Weight**	**Competences**
Final Exam	40%	CB6, CB7, CE4
Continuous Assessment Activities	35%	CB6, CB7, CE4
Reports and Presentationa	15%	CB6, CB7, CE4
Participation	10%	CB6, CB7, CE4

LEARNING OUTCOMES (Explanation of the embodiments that allow competences evaluation of student, relating them to the competences and evaluation methods.)

- The student must demonstrate knowledge and understanding of what constitutes a basis or an opportunity to be original by developing and/or applying ideas, often in a research context (CB6).
- The student must demonstrate ability to apply their knowledge and their ability to solve problems in new or unfamiliar environments within broader (or multidisciplinary) contexts related to his/her field of study (CB7).
- The student must demonstrate ability to solve problems that are unfamiliar, incompletely

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defined, and have contradictory specifications, considering the possible methods of solution, including the most innovative, selecting the most appropriate, being able to correct implementation and evaluating the different design solutions (CE4).

QUALIFICATION (Explanation of the system used for the grade of the student.) The rating of this subject is obtained:

Final Exam:	40%
Continuous Assessment Activities:	35%
Reports and Presentations:	15%
Participation:	10%

- The final exam includes mainly practical aspects.
- Continuous assessment activities include
  - theoretical tests of the different topics of the subject and
  - the resolution of cases by pairs (worked both inside and outside the classroom), discussed during the classes and delivered during the course at specified dates.
- Works (studies and presentations) are performed by students individually or in pairs and delivered during the course on the established dates.
- The participation includes attendance, initiative and the attitude shown by the student.

ASSESSMENT OF THE COMPETENCES (Define calculation expressions for each competence and the relevant evaluation methods.)

The rating of each competition will be performed according to the percentages indicated in the "Rate" section for each of the methods specified rating in the table, then normalized to 100%.

BIBLIOGRAPHY (Recommended and accessible to students.)

- BOX GEP, WG HUNTER, HUNTER JS; Statistics for researchers; Ed Reverté SA.; Barcelona; 2008.
- BOX GEP, JS HUNTER, HUNTER WG; Statistics per a científics i tècnics. Disseny d'experiments and Innovation; Reverté Ed.; Barcelona; 2008.
- BOX GEP, DRAPER NR; Empirical model building and response surfaces; Wiley; 1987.
- BOX GEP, DRAPER NR; Response surfaces, Mixtures and ridge analysis; Wiley; 2007

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- CARLSON R .; Design and optimization in organic synthesis; Elsevier; 1992.
- CORNELL JA; A first on Experiments with Mixtures; Wiley; 2011.
- MONTGOMERY DC; Der experiments design and analysis; Limusa; 2005.
- MYERS RH, MONTGOMERY DC, ANDERSON-COOK CM; Response surface methodology: process and product optimizations using designed experiments; J. Wiley; 2009.
- PARK SH; Robust design for Quality Engineering and Six Sigma; Chapman & Hall; 2008.
- WALTERS FH, LR PARKER Jr., MORGAN SL, SN DEMING; Sequential simplex optization: a tecnique for Improving quality and productivity in research, developement and manufacturing; CRC Press, 1991.

DOCUMENT HISTORY

PREVIOUS CHANGES (You set the date and author / s, the most recent first)
NA

LAST REVISION (Indicate date and author / s.)
February 26, 2019, Dr. Laura Fernández-Ruano