Course guide
220109 - DECQ - Experimental Designs and Quality Control

Unit in charge: Terrassa School of Industrial, Aerospace and Audiovisual Engineering
Teaching unit: 715 - EIO - Department of Statistics and Operations Research.

Degree: BACHELOR'S DEGREE IN INDUSTRIAL TECHNOLOGY ENGINEERING (Syllabus 2010). (Compulsory subject).

Academic year: 2022  ECTS Credits: 4.5  Languages: Catalan

LECTURER

Coordinating lecturer: Algaba Joaquin, Ines M.

Others: Pérez Álvarez, Susana
        Rivera Fusalba, Oriol

DEGREE COMPETENCES TO WHICH THE SUBJECT CONTRIBUTES

Specific:
1. The ability to solve mathematical problems that may arise in an engineering context. The ability to apply knowledge of linear algebra; geometry; differential geometry; differential and integral calculus; differential and partial differential equations; numerical methods; numerical algorithms; statistics and optimisation
2. Applied knowledge of manufacturing systems and processes, metrology and quality control

General:
3. THE ABILITY TO ANALYSE AND SYNTHESISE: The ability to think abstractly about the fundamental concepts of a text or exposition and to intelligibly present the result of one's work.
TEACHING METHODOLOGY

Although this course is clearly applicable in professional engineering activities, it requires solid theoretical and practical knowledge of statistics. Therefore, a requirement to be able to succeed in the present course is having enrolled and passed the second year 6 ECTS course “Statistics”.

A real problem to be addressed is introduced at the beginning of each theory lesson. The appropriate statistical tools and methods needed to solve the problem are presented together with a previous description of the concepts that are the basis of their development. The second part of each lesson is a real case study in which the student becomes conscious of the practical application of each method and can check if he/she has understood correctly the involved concepts. The lectures are complemented with a weekly session of exercises and problems.

Although there are a number of literature references regarding the course topics, only few of them have the needed precision and accuracy. The available manuals are often recipes collections with application examples. Generally, they lack of a rigorous explanation of the techniques that is essential for the engineers in order to be able to adapt to different situations and design their own custom-made technique. To achieve this objective, the techniques of quality control and design of experiments will be presented with the highest statistical accuracy in the lecturing sessions, although avoiding abstract theory, and will be illustrated with real examples of application.

Therefore, all the theoretical lectures (activity 1) are given using multimedia materials specially created by the teachers of the course which give special focus to the most important points and those that are more challenging. These materials are made available to all students in pdf format through the digital platform Atenea.

One way to consolidate the learnt concepts is through the development of problems and numerical exercises. For this reason, a collection of problems solved in detail is available for the students. They will know one week in advance the exercises that will be discussed in the classroom, so that they can work previously on them and thus participate and discuss on the concepts and methodology required to deal with each situation. Although every week there is one session of problems (activity 2), theory lessons also include several numerical examples and case studies.

At the end of each topic of the syllabus, a collection of problems, exercises and theoretical questions is made available in Atenea, which should be used for self-assessment (activity 3). These exercises will not be solved in classroom and their detailed solution will not be given; only the numerical results will be published. Doubts that arise solving these problems, consulting the literature provided in this guide or the course notes, will be solved by the professors during attention hours.

In addition, since this subject has a strong computing component, the student will learn to use computers to solve problems. Despite there exists a large amount of statistical software it is not always available to all companies. In this course, by the completion of two projects (activities 4 and 5), the student learns how to resolve a number of statistical problems that he/she may face using a simple spreadsheet and the required statistical concepts.

Observation: this course might be taught in Spanish if needed

LEARNING OBJECTIVES OF THE SUBJECT

The course has two main objectives. The first one is to introduce the students to the techniques of statistical quality control of industrial processes. The second is to enable them to carry out the planning and execution of the required experimentation, as well as its interpretation in order to model the behaviour of industrial processes, which will make possible the optimization, performance improvement, costs reduction, achievement of goals, reduction of environmental pollution, noise or waste water.

STUDY LOAD

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<tr>
<th>Type</th>
<th>Hours</th>
<th>Percentage</th>
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<tbody>
<tr>
<td>Self study</td>
<td>67,5</td>
<td>60.00</td>
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<tr>
<td>Hours medium group</td>
<td>14,0</td>
<td>12.44</td>
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<tr>
<td>Hours large group</td>
<td>31,0</td>
<td>27.56</td>
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**Total learning time:** 112.5 h
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<td>1.2. Graphical tools</td>
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<tr>
<td><strong>Full-or-part-time:</strong> 5h</td>
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<tr>
<td>Theory classes: 1h</td>
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<td>Practical classes: 1h</td>
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<td>2.1. Capability study</td>
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<td><strong>Full-or-part-time:</strong> 7h 30m</td>
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<td>Theory classes: 2h</td>
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<td>Practical classes: 1h</td>
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<td>Self study: 4h 30m</td>
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<td>3.1. Statistical Process Control: control charts</td>
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<td>3.2. Control upon reception</td>
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<td><strong>Full-or-part-time:</strong> 25h</td>
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<tr>
<td>Theory classes: 7h</td>
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<td>Practical classes: 3h</td>
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<td>Self study: 15h</td>
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<th>Module 4. Experimental Design &amp; Statistical Tools</th>
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<td><strong>Full-or-part-time:</strong> 25h</td>
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<td>Theory classes: 8h</td>
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<td>Practical classes: 2h</td>
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<td>Self study: 15h</td>
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<td>5.1. Factorial Designs</td>
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<td>5.2. Fractional Factorial Designs</td>
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<td><strong>Full-or-part-time:</strong> 25h</td>
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<td>Theory classes: 7h</td>
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<td>Practical classes: 3h</td>
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<td>Self study: 15h</td>
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Module 6. Experimental Design ' Modelling the mean with non-constant variance

**Description:**
6.1. Modelling variability
6.2. Modelling the mean response by Weighted Least Squares

**Full-or-part-time:** 12h 30m
Theory classes: 3h
Practical classes: 2h
Self study: 7h 30m

Module 7. Experimental Design & Sequential Design

**Description:**
7.1. Sequential Design

**Full-or-part-time:** 12h 30m
Theory classes: 3h
Practical classes: 2h
Self study: 7h 30m

**ACTIVITIES**

**ACTIVITY 1: THEORETICAL LECTURES**

**Related competencies:**
08 CAS N3. THE ABILITY TO ANALYSE AND SYNTHESISE: The ability to think abstractly about the fundamental concepts of a text or exposition and to intelligibly present the result of one's work.
CE01. The ability to solve mathematical problems that may arise in an engineering context. The ability to apply knowledge of linear algebra; geometry; differential geometry; differential and integral calculus; differential and partial differential equations; numerical methods; numerical algorithms; statistics and optimisation
ITI-CE24. Applied knowledge of manufacturing systems and processes, metrology and quality control

**Full-or-part-time:** 47h
Theory classes: 27h
Self study: 20h

**ACTIVITY 2: PROBLEM SOLVING SESSIONS**

**Related competencies:**
08 CAS N3. THE ABILITY TO ANALYSE AND SYNTHESISE: The ability to think abstractly about the fundamental concepts of a text or exposition and to intelligibly present the result of one's work.
CE01. The ability to solve mathematical problems that may arise in an engineering context. The ability to apply knowledge of linear algebra; geometry; differential geometry; differential and integral calculus; differential and partial differential equations; numerical methods; numerical algorithms; statistics and optimisation
ITI-CE24. Applied knowledge of manufacturing systems and processes, metrology and quality control

**Full-or-part-time:** 28h
Practical classes: 14h
Self study: 14h
ACTIVITY 3: SELF-ASSESSMENT EXERCISES

Related competencies:
08 CAS N3. THE ABILITY TO ANALYSE AND SYNTHESISE: The ability to think abstractly about the fundamental concepts of a text or exposition and to intelligibly present the result of one's work.
CE01. The ability to solve mathematical problems that may arise in an engineering context. The ability to apply knowledge of linear algebra; geometry; differential geometry; differential and integral calculus; differential and partial differential equations; numerical methods; numerical algorithms; statistics and optimisation
ITI-CE24. Applied knowledge of manufacturing systems and processes, metrology and quality control

Full-or-part-time: 13h
Self study: 13h

ACTIVITY 4: PROJECT ON QUALITY CONTROL

Description:

Related competencies:
08 CAS N3. THE ABILITY TO ANALYSE AND SYNTHESISE: The ability to think abstractly about the fundamental concepts of a text or exposition and to intelligibly present the result of one's work.
CE01. The ability to solve mathematical problems that may arise in an engineering context. The ability to apply knowledge of linear algebra; geometry; differential geometry; differential and integral calculus; differential and partial differential equations; numerical methods; numerical algorithms; statistics and optimisation
ITI-CE24. Applied knowledge of manufacturing systems and processes, metrology and quality control

Full-or-part-time: 5h
Self study: 5h

ACTIVITY 5: PROJECT ON EXPERIMENTAL DESIGN

Description:

Related competencies:
08 CAS N3. THE ABILITY TO ANALYSE AND SYNTHESISE: The ability to think abstractly about the fundamental concepts of a text or exposition and to intelligibly present the result of one's work.
CE01. The ability to solve mathematical problems that may arise in an engineering context. The ability to apply knowledge of linear algebra; geometry; differential geometry; differential and integral calculus; differential and partial differential equations; numerical methods; numerical algorithms; statistics and optimisation
ITI-CE24. Applied knowledge of manufacturing systems and processes, metrology and quality control

Full-or-part-time: 5h
Self study: 5h
ACTIVITY 6: PARTIAL EXAM

Description:

Related competencies:
08 CAS N3. THE ABILITY TO ANALYSE AND SYNTHESISE: The ability to think abstractly about the fundamental concepts of a text or exposition and to intelligibly present the result of one's work.
CE01. The ability to solve mathematical problems that may arise in an engineering context. The ability to apply knowledge of linear algebra; geometry; differential geometry; differential and integral calculus; differential and partial differential equations; numerical methods; numerical algorithms; statistics and optimisation
ITI-CE24. Applied knowledge of manufacturing systems and processes, metrology and quality control

Full-or-part-time: 6h 30m
Theory classes: 1h 30m
Self study: 5h

ACTIVITY 7: FINAL EXAM

Description:

Related competencies:
08 CAS N3. THE ABILITY TO ANALYSE AND SYNTHESISE: The ability to think abstractly about the fundamental concepts of a text or exposition and to intelligibly present the result of one's work.
CE01. The ability to solve mathematical problems that may arise in an engineering context. The ability to apply knowledge of linear algebra; geometry; differential geometry; differential and integral calculus; differential and partial differential equations; numerical methods; numerical algorithms; statistics and optimisation
ITI-CE24. Applied knowledge of manufacturing systems and processes, metrology and quality control

Full-or-part-time: 8h
Theory classes: 2h 30m
Self study: 5h 30m

GRADING SYSTEM

The final grade depends on 4 evaluations:
- Activity 4 (project on Quality Control), with a weight of 10%
- Activity 5 (project on Experimental Design) with a weight of 10%
- Activity 6 (partial exam) with a weight of 40%
- Activity 7 (final exam) with a weight of 40%

Any student who cannot attend to the midterm exam (activity 6) or that wants to improve the obtained grade, will have the opportunity to improve that grade by taking an additional written exam that will take place the same day as the final exam (activity 7). The grade obtained in this test will range between 0 and 10, and will replace that of the midterm exam in case it is higher.

EXAMINATION RULES

Anyone that does not attend to any of the evaluative activities will be graded with a 0 if he/she has attended any other one.

BIBLIOGRAPHY

Basic:
Complementary: