220109 - Experimental Designs and Quality Control

Coordinating unit: 205 - ESEIAAT - Terrassa School of Industrial, Aerospace and Audiovisual Engineering
Teaching unit: 715 - EIO - Department of Statistics and Operations Research
Academic year: 2019
Degree: BACHELOR'S DEGREE IN INDUSTRIAL TECHNOLOGY ENGINEERING (Syllabus 2010). (Teaching unit Compulsory)
ECTS credits: 4,5
Teaching languages: Catalan

Teaching staff
Coordinator: 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

Generical:
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.
220109 - Experimental Designs and Quality Control

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**

<table>
<thead>
<tr>
<th>Total learning time: 112h 30m</th>
<th>Hours large group: 31h 27.56%</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Hours medium group: 14h 12.44%</td>
</tr>
<tr>
<td></td>
<td>Hours small group: 0h 0.00%</td>
</tr>
<tr>
<td></td>
<td>Guided activities: 0h 0.00%</td>
</tr>
<tr>
<td></td>
<td>Self study: 67h 30m 60.00%</td>
</tr>
</tbody>
</table>
## Content

<table>
<thead>
<tr>
<th>Module 1. Quality Control &amp; Introduction</th>
<th>Learning time: 5h</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Description:</strong></td>
<td></td>
</tr>
<tr>
<td>1.1. Introduction</td>
<td></td>
</tr>
<tr>
<td>1.2. Graphical tools</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Module 2. Quality Control &amp; Process Capability</th>
<th>Learning time: 7h 30m</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Description:</strong></td>
<td></td>
</tr>
<tr>
<td>2.1. Capability study</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Module 3. Quality Control &amp; Control techniques</th>
<th>Learning time: 25h</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Description:</strong></td>
<td></td>
</tr>
<tr>
<td>3.1. Statistical Process Control: control charts</td>
<td></td>
</tr>
<tr>
<td>3.2. Control upon reception</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Module 4. Experimental Design &amp; Statistical Tools</th>
<th>Learning time: 25h</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Description:</strong></td>
<td></td>
</tr>
<tr>
<td>4.1. Linear Regression</td>
<td></td>
</tr>
</tbody>
</table>
## Module 5. Experimental Design ¿ Modelling the mean with constant variance

**Description:**
- 5.1. Factorial Designs
- 5.2. Fractional Factorial Designs

**Learning time:** 25h
- Theory classes: 7h
- Practical classes: 3h
- Self study: 15h

## 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

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

## Module 7. Experimental Design ¿ Sequential Design

**Description:**
- 7.1. Sequential Design

**Learning time:** 12h 30m
- Theory classes: 3h
- Practical classes: 2h
- Self study: 7h 30m
### Planning of activities

| ACTIVITY 1: THEORETICAL LECTURES | Hours: 47h  
Theory classes: 27h  
Self study: 20h |
|----------------------------------|----------------|
| ACTIVITY 2: PROBLEM SOLVING SESSIONS | Hours: 28h  
Practical classes: 14h  
Self study: 14h |
| ACTIVITY 3: SELF-ASSESSMENT EXERCISES | Hours: 13h  
Self study: 13h |
| ACTIVITY 4: PROJECT ON QUALITY CONTROL | Hours: 5h  
Self study: 5h |
| ACTIVITY 5: PROJECT ON EXPERIMENTAL DESIGN | Hours: 5h  
Self study: 5h |
| ACTIVITY 6: PARTIAL EXAM | Hours: 6h 30m  
Theory classes: 1h 30m  
Self study: 5h |
| ACTIVITY 7: FINAL EXAM | Hours: 8h  
Theory classes: 2h 30m  
Self study: 5h 30m |
Qualification 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.

Regulations for carrying out activities

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:


Others resources: