240055 - Statistical Techniques for Quality

Coordinating unit: 240 - ETSEIB - Barcelona School of Industrial 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)
BACHELOR’S DEGREE IN MATERIALS ENGINEERING (Syllabus 2010). (Teaching unit Compulsory)
ECTS credits: 3
Teaching languages: Catalan

Teaching staff

Coordinator: Lluís Marco Almagro
Others: Jesús Corral López, Martí Font Valverde, Sara Fontdecaba Rigat, Jan Graffelman, Pere Grima Cintas, Lluís Marco Almagro, Xavier Puig Oriol, Lourdes Rodero de Lamo, Josep Anton Sánchez Espigares, Xavier Tort-Martorell Llabrés

Opening hours

Timetable: Available on Atenea intranet

Prior skills

One must know the contents of the course "Statistics", specifically:
- Have a clear idea of variability
- Know probability distributions (such as normal, t-student, ...)
- Be able to perform a comparison of treatments (t-test)
- Know how to fit linear regression models.
- Know the software package MINITAB

Degree competences to which the subject contributes

Specific:
CEMI6. Knowledge applied to quality control.

CETI6. Knowledge applied to manufacturing systems and processes, metrology and quality control.

Transversal:
07 AAT. SELF-DIRECTED LEARNING. Detecting gaps in one's knowledge and overcoming them through critical self-appraisal. Choosing the best path for broadening one's knowledge.
04 COE. EFFICIENT ORAL AND WRITTEN COMMUNICATION. Communicating verbally and in writing about learning outcomes, thought-building and decision-making. Taking part in debates about issues related to the own field of specialization.
05 TEQ. TEAMWORK. Being able to work as a team player, either as a member or as a leader. Contributing to projects
The purpose is that the student knows the most relevant statistical tools to improve industrial and service processes, framed within the improvement quality methodology Six Sigma.

Specifically, at the end of the course students will be able to:

- Address an improvement project following the steps of the Six Sigma methodology.
- Select designs to analyze the behavior of a product or process in both the mean and variance transmitted by uncontrollable factors.
- Analyze the effect of control factors and noise factors on the response of interest and select the most robust conditions.
- Conduct capacity studies to characterize the variability of a process and compare it with specifications.
- Use control charts for continuous and discrete variables to know when to act on a process to keep the variability in its minimum level.
- Validate measurement systems using R&R studies.
- Understand the main concepts in reception control.
- Perform nonparametric and parametric reliability analysis.

### Learning objectives of the subject

<table>
<thead>
<tr>
<th>Total learning time: 75h</th>
<th>Hours large group:</th>
<th>0h</th>
<th>0.00%</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>Hours medium group:</td>
<td>30h</td>
<td>40.00%</td>
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<tr>
<td></td>
<td>Hours small group:</td>
<td>0h</td>
<td>0.00%</td>
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<tr>
<td></td>
<td>Guided activities:</td>
<td>0h</td>
<td>0.00%</td>
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<tr>
<td></td>
<td>Self study:</td>
<td>45h</td>
<td>60.00%</td>
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The sessions of the course are based on:

- Lectures and participatory classes
- Problem-based learning
- Cooperative learning

This course requires an autonomous learning of the student before class (preparation of the session) and after class.

### Study load

Teaching methodology: Lectures and participatory classes, Problem-based learning, Cooperative learning.
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<table>
<thead>
<tr>
<th>Statistics and Quality. Basic Tools. Six Sigma Process Improvement Methodology</th>
<th>Learning time: 12h</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Practical classes: 6h</td>
</tr>
<tr>
<td></td>
<td>Guided activities: 2h</td>
</tr>
<tr>
<td></td>
<td>Self study : 4h</td>
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</tbody>
</table>

## Description:

### Related activities:
- Reflective exercises on the importance of data-driven decisions.
- Application of basic tools using MINITAB.
- Solving practical cases following the Six Sigma methodology.

### Specific objectives:
At the end of the course the students will be able to:

- Describe the importance of statistics in quality.
- Apply basic (mainly graphical) tools for quality improvement.
- Describe how the Six Sigma improvement methodology works.
- Develop an improvement project following the phases of the Six Sigma methodology.
## Experimental Design and Robust Desing

**Learning time:** 12h  
- Practical classes: 6h  
- Guided activities: 2h  
- Self study: 4h

### Description:

### Related activities:
- Problems, cases and exercises with and without MINITAB
- Application of experimental design to a real case in teams. Design, implementation and analysis of the experiment. Drawing conclusions, presentation of the report
- Independent learning reading cases and extensions of the techniques suggested in the literature

### Specific objectives:
- At the end of the course the students will be able to:
  - Select designs to analyze the behavior of a product or process mean and variance transmitted by uncontrollable factors.
  - Analyze the effect of control and noise factors in the response of interest and select the most robust conditions.
  - Explore the region of interest of the experimental variables that maximize (minimize) the response and study the nature of the surface.
  - Design and implement real experiments following a sequential strategy, from the experimental plan approach to drawing final conclusions.
  - Work in teams to agree on decisions and solve problems together.
### Capability studies. Statistical Process Control

<table>
<thead>
<tr>
<th>Learning time: 9h</th>
</tr>
</thead>
<tbody>
<tr>
<td>Practical classes: 4h</td>
</tr>
<tr>
<td>Guided activities: 2h</td>
</tr>
<tr>
<td>Self study: 3h</td>
</tr>
</tbody>
</table>

**Description:**

**Related activities:**
- Resolution of cases with MINITAB
- Implement statistical process control in a real process, given the nature of the process and its associated costs

**Specific objectives:**
- At the end of the course the students will be able to:
  - Understand and explain why the variability is the enemy of quality.
  - Use graphical techniques to detect the most important sources of variability of a system.
  - Perform capability studies to characterize the variability of a process and compare it to the specifications.
  - Use control charts for continuous and discrete variables to know when to act on a process to keep the variability in its minimum level.

### R&R studies, reception inspection, reliability

<table>
<thead>
<tr>
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</thead>
<tbody>
<tr>
<td>Practical classes: 6h</td>
</tr>
<tr>
<td>Guided activities: 2h</td>
</tr>
<tr>
<td>Self study: 4h</td>
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</tbody>
</table>

**Description:**

**Related activities:**
- Validation of a measurement system
- Design of an incoming reception plan
- Using MINITAB for reliability studies

**Specific objectives:**
- After completing the course the students will be able to:
  - Validate measurement systems.
  - Design an incoming inspection plan based on the desired quality level and buyer and seller risks
  - Understand the utility and also the complexity of reliability studies
  - Perform simple reliability studies
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## Planning of activities

### PRACTICAL CASES, PROBLEMS AND EXERCISES

| Description: | Students will solve (individually or in groups) cases, problems and exercises about the course contents |
| Support materials: | Students will have the MINITAB software package, statements of cases and exercises; and after its resolution, in many cases, a standard solution |
| Specific objectives: | Consolidate the self-studied concepts and those introduced in the classes and develop the ability to apply this knowledge to gradually more complex real situations |

| Hours: | 2h 30m |
| Self study: | 2h 30m |

### FOLLOW-UP

| Description: | Answer to questions about the material covered in the subject |
| Support materials: | Explanations and online questionnaires |
| Descriptions of the assignments due and their relation to the assessment: | Response to questionnaires with immediate feedback |
| Specific objectives: | Motivate the study of the subject |
| | Check the understanding of the main concepts. |

| Hours: | 2h 30m |
| Self study: | 2h 30m |

### TEAM WORK

| Description: | Students will plan, implement and analyze an experiment. Teachers will support the student with the project. The project will be done in groups. |
| Support materials: | This work is a practical application of a big part of the course material and therefore the material is that used during the course as well as the additional references. |
| Descriptions of the assignments due and their relation to the assessment: | A written report and a video explaining all the work steps and the conclusions |
| Specific objectives: | To apply statistical tools to a real case. Measure real data. |

| Hours: | 12h |
| Guided activities: | 12h |

### PAPER

| Hours: | 4h |
| Guided activities: | 4h |
**Description:**
Study of a paper related with the topics covered in the subject

**Support materials:**
The article, which is provided through the intranet, and all course materials.

**Descriptions of the assignments due and their relation to the assessment:**
The form of presentation of the results of the paper study will be announced on the intranet, and will depend on the availability of sessions each semester. The final exam may include questions about the papers.

**Specific objectives:**
Deepen some aspect of statistical techniques for quality control and improvement,
Confront a scientific paper (in English)

<table>
<thead>
<tr>
<th><strong>PARTIAL EXAM</strong></th>
<th><strong>Hours:</strong> 4h</th>
</tr>
</thead>
<tbody>
<tr>
<td>Description:</td>
<td>Self study: 2h</td>
</tr>
<tr>
<td></td>
<td>Theory classes: 2h</td>
</tr>
</tbody>
</table>

**Description:**
Exam that will cover all the contents up to this point.

**Descriptions of the assignments due and their relation to the assessment:**
The exam itself.

**Specific objectives:**
Evaluate the knowledge acquired up to this point

<table>
<thead>
<tr>
<th><strong>FINAL EXAM</strong></th>
<th><strong>Hours:</strong> 5h</th>
</tr>
</thead>
<tbody>
<tr>
<td>Description:</td>
<td>Theory classes: 2h</td>
</tr>
<tr>
<td></td>
<td>Self study: 3h</td>
</tr>
</tbody>
</table>

**Description:**
Exam that will cover all the contents in the course.

**Descriptions of the assignments due and their relation to the assessment:**
The exam itself.

**Specific objectives:**
Evaluate the knowledge acquired during the course
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Qualification system

The course grade will be calculated from the following formula:

\[ \text{Mark} = 0.25 \times \text{FollowupTasks} + 0.25 \times \text{PartialExam} + 0.50 \times \text{FinalExam} \]

For those students with the right to perform the re-evaluation exam, the course grade will be calculated from the following formula:

\[ \text{Mark} = 0.25 \times \text{FollowupTasks} + 0.75 \times \text{Re-evaluationExam} \]

The qualification from the Re-evaluation exam will therefore replace the qualifications of the final exam and the partial exam.

Regulations for carrying out activities

The current regulations at UPC and ETSEIB

Bibliography

Basic:


Complementary: