The goal is for the student to be able to design and implement an experimentation plan to determine how a series of variables (controllable or not) in a process affect a particular aspect of quality. To this effect, tools such as design of experiments and response surface methodology are employed. Specifically, on completion of the course, students should be able to:

- Choose designs for analyzing the behaviour of a product or a process, both for the mean and for the variance transmitted by uncontrollable factors.
- Analyze the effect of control and noise factors in the response and choose the most robust conditions.
- Choose designs for exploring second-order polynomial response surfaces (central composite design, Box-Behnken design, etc.)
- Explore the area of interest of the experimental variables that maximize (minimize) the response, and study the nature of the surface.
- Design real experiments and implement them by following a sequential strategy, from the initial layout of the experimental plan to the final conclusions.
- Work as part of a team to arrive at consensus decisions and solve problems jointly.
- Express ideas and results effectively, both orally and in written form.
Skills to be learned
* Learn and understand the concept of robust product and process, be aware of its importance and provide examples.
* Understand the difference between control factors and noise factors. Be able to decide what the control and noise factors in an experiment design will be.
* Learn how to create an experiment design in a real process, tackling all the difficulties that may arise (such as measuring the response, gathering data, assigning roles to team members, controlling time, etc.).
* Learn to apply a sequential strategy in experimentation: screening designs, fractional factorial designs, full factorial designs, designs with central points, response surface.
* Create design matrices and analyze the results of the experimentation using Minitab software.
* Learn how to condense what has been discovered about a process in a precise report with graphs and descriptions.
* Learn how to make a clear oral presentation of the conclusions of an experiment.
* Be familiar with the controversies and avenues of research in the design of robust products and processes.
### The importance of experimentation.

**Description:**
- Experimentation for progress in knowledge. Statistics as a tool of the scientific method.
- Relation between statistics and quality.

### Factorial designs

**Description:**
- Blocking in factorial designs. Plackett and Burman designs. Factorial designs of more than 2 levels. Central points.

### Response surface methodology

**Description:**
- Response surface in $2^{(k-p)}$ designs using first degree polynomials: use of the steepest ascent for approaching the region of interest. Steepest ascent subject to restrictions. Response surface using second degree polynomials: central composite design and Box-Behnken design. Model fitting. Surface characterization by means of canonical analysis.

### Robust products and processes design.

**Description:**

### Other experimental design and process optimization topics.

**Description:**
- The role of experiment design in the stages of a quality improvement process. Controversy around Taguchi's methodology. Comparison of methods of analysis: product matrix and extended matrix. Evolutionary operation (EVOP). Orders of experimentation providing minimum bias. Discussion of real cases of experiments developed in industry.
This course is subject to continuous assessment with the aim of encouraging involvement and providing students with information about their progress towards the achievement of the course objectives. The programmed activities (which will count towards the final result) are the following:

* Assessment tests (20%): exercises applying course content. To be handed in approximately every three weeks.
* Helicopter practicals (20%): optimization of the time it takes a paper helicopter to fall, using techniques studied during the course.
* Robust product design practicals (15%).
* Response surface practicals (10%).
* Synthesis questionnaire (35%): a test on course concepts, to be done without notes or support material.

**Prior skills**

* A clear idea of variability, including how to measure it and what graphic tools can be used to represent it (Foundations of Quality Control course).
* Know how to fit linear models, make inferences on their parameters and validate the model (Linear Models course).
* Basic knowledge of the use of Minitab.

**Bibliography**

**Basic:**


**Complementary:**


