The aim of the course is for the student to understand the importance of combating variability in order to improve quality, to learn how to characterize the variability of a process and to learn techniques for reducing variability and keeping them at minimum levels. The goal is also for the student to acquire an overall practical vision of tools useful for quality improvement programmes, some of which are not included in other topics on the course concerning quality.

Specifically, on completion of the course, students should be able to:

* Understand and explain why variability is inimical to quality.
* Use graphical techniques for detecting the most important sources of variability in a system.
* Carry out capacity studies for characterizing the variability of a process and compare it with the specifications.
* Use control charts for continuous and discrete variables in order to know when it is necessary to take action on a process to maintain variability at its lowest level.
* Understand and use sophisticated control charts.
* Implant a statistic process control in a real process, bearing in mind the nature of the process and the associated costs.
* Carry out reproducibility and repeatability studies in order to ensure that the measurement system employed in a process is appropriate.
* Extract relevant information and learn from books and articles.
* Work in groups in order to arrive at consensus decisions and solve problems jointly.
* Communicate concepts, ideas and results in an effective way, both in written form and orally.

Skills to be learned

* To be aware of the presence of variability in all real processes and the importance of reducing it.
* Know how to choose a statistical control policy for a range of processes, in terms of the variable to be monitored and taking into account available resources.
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* Know how to use the MINITAB statistical software for creating out control charts, capacity studies, multivariate graphs and R&R studies, as well as Excel for drawing control charts.
* Know how to use templates for making control charts and capacity studies, as well as understanding their usefulness for the computer.
* Know how to seek information unaided on subjects that may be of interest in the task to be carried out.
* Possess a clear general vision of the statistical techniques that can be used in quality improvement programmes.
* To be able to set up and run a quality improvement programme from the definition phase to the implantation of improvement.
* To be able to tackle technical articles confidently, understand them and condense the information in an oral presentation.
## Variability. Multivariate graphs

**Description:**
Review: causes and measures of variability. Concept and example of multivariate graphs.

## Capacity studies.

**Description:**

## Basic methods of statistical process control.

**Description:**
Conditions for SPC to be useful. Stages in the implantation of the SPC: data gathering, reference model and alarm criteria. False alarm risk and power of detection. Concept of rational subgroup and ARL (Average Run Length). Xbar-R charts. I-MR charts. P and NP graphs. C and U graphs. Pros and contras of these charts and graphs. Choosing the appropriate control chart according to the variable to be monitored.

## Other statistical process control charts.

**Description:**

## Multivariate control charts.

**Description:**
Motivation for multivariate control charts. Hotelling's $T^2$. Examples.

## Adaptive control processes.

**Description:**
Difference between SPC (Statistical Process Control) and EPC (Engineering Process Control). Example of differential control.
Repeatability and Reproducibility (R&R) studies.

**Description:**
Repeatability and reproducibility (R&R) studies for continuous variables. Repeatability and reproducibility (R&R) studies for discrete variables.

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**Qualification system**

Course progress evaluated by continuous assessment with the purpose of motivating students and providing them with information about their progress towards the achievement of the course objectives.

Programmed activities (which count toward the final result) are the following:
* Assessment exercises (15%): exercises in which the course content is applied. They must be handed in approximately every three weeks.
* Article (15%): presentation of a technical article dealing with some of the course topics
* The catapult practical (10%): data gathering design and analysis of the process of casting projectiles with a catapult.
* Exercise (10%): exercise of synthesis consisting of the preparation of a problem on the content of the course.
* The case (15%): a real case in which the techniques studied during the course are brought to bear.
* Synthesis questionnaire (35%): a test on the concepts studied during the course; must be answered without notes or support material.

**Prior skills**

* A clear idea of variability, how it is measured and what graphic tools can be used to represent it (Foundations of Quality Control course).
* Some basic notions on the use of MINITAB and Excel are required.

**Bibliography**

**Basic:**


**Complementary:**