UNICUSANO
ROME

**Code: IND-ENG/17 (Mechanical Industrial Systems)** **Credits: 9**
**Matter:** Industrial Plants Management
**Main language of instruction:** Italian
**Other language of instruction:** English

**Teaching Staff**

**Head instructor**
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## Introduction

1. *Objective of the course:*

The teaching of the course of "Industrial Plants Management" aims to achieve the following educational objectives:

- Review the concepts about the availability of productive resources and about the measurement of industrial plant performance;
- Illustrate the Overall Equipment Effectiveness (OEE) measurement, based on the main operating states of an industrial plant;
- Illustrate the Design of Experiments (DoE), for the evaluation of the significance of each factor and the optimization of a productive process;
- Explain the method of Analysis of Variance (Anova), one-way or more, in order to deal with factorial experiments with one or more factors;
- Illustrate the different techniques for the production quality management, in particular in relation to Statistical Process Control (SPC) and Acceptance Control (AC), as well as the principles of the quality certification and ISO 9001;
- Illustrate the Toyota Production System (TPS) and the main criteria about Lean Production and Just in Time (JIT).

## Objectives

2. *Course Structure:*

The course is organized in five modules. The aim of the course is to reach a good knowledge of the quality control methods in the productive systems, of DoE and Anova statistical techniques, of the performance measurement of a productive process and of the Lean Production philosophy. The course aims to illustrate the key concepts about the Statistical Process Control, referring above all to the use of Control Charts within the 7 quality tools, as well as the differences between the

natural tolerance of a process and the design tolerance. The target is to check the state of control of a productive process, analyzing the main process capacity indicators. Among the educational targets of the course, there is the exposure of some of the main ideas developed by Tagushi about the quality, as well as the defining of the principles about total quality, then to describe the applications tools and the philosophy at the base of the Lean Production, such as JIT and Kanban system. At the same time, the course clarifies the key aspects about the Design of Experiments, the design and improvement of a production process, as well as the definition of the plant operating conditions, the availability of a productive resource and the Overall Equipment Effectiveness. To influence the rigor of learning, the course contains a practical part consisting of the resolution of two E-Tivities. They develop the skills necessary to correctly set up problems related to statistical quality control and design of experiments, choosing and correctly applying the most appropriate methods for their resolution.

## Competencies:

A. Knowledge and understanding

At the end of the course, the student will have demonstrated knowledge of the main principles of quality control in production, of the 7 quality tools and of lot for lot acceptance control, thus acquiring an ability to analyze these topics. Furthermore, the student will acquire the knowledge of the principles of total quality, JIT and Lean Production, as well as quality costs and ISO 9001 standard. Furthermore, the student will acquire knowledge about the calculation of the productivity of a Plant, based on of its operating conditions, and about the principles behind the design and improvement of a production process, the analysis of variance and the application of the response surface methodology. Moreover, the students will acquire the ability to correctly formulate problems related to statistical quality control in production, as well as to the characterization and optimization of a production process by means of the E-Tivities execution.

B. Applying knowledge and understanding

The student will be able to use its knowledge about the 7 quality tools (and in particular control charts) to correctly analyze a production process, calculate its capacity and verify the design tolerances. It will also be able to choose the most suitable control chart for the specific process, as well as to apply the most appropriate methodologies for programming experiments for the design and improvement of a production process. Finally, the E-Tivities will provide for the application of theoretical knowledge to practical problems of designing experiments and statistical quality control in production.

C. Making judgements.

The student will be able to identify the most suitable quality tools for the statistical control of a production process, as well as the most appropriate experimental techniques for the desing and improvement of a production process. At the same time, he will be able to distinguish the causes behind the loss of productivity of a plant, calculating coefficients of performance and use of a machine and verifying the correct application of the Lean Production principles and the reduction of waste production.

D. Communication skills

The student will be able to describe and support conversations on problems related to design and optimization of production processes, as well as to quality management and statistical process control, correctly identifying the relevant data and using an appropriate terminology in the field of production systems and industrial plants.

E. Learning skills

At the end of the course, the student will have knowledge of the fundamental notions necessary for the analysis of the performance of a machine or a production plant, as well as for the analysis of the capacity of a production process and the optimization of a production process. All that will allow him to acquire an overview in relation to the management of Industrial Plants, allowing him to continue his engineering studies with greater ease and maturity, managing to inter-disciplinarily connect production processes, with their statistical control and performance monitoring.

## Syllabus

*3. Programme of the course:*

**Subject 1. OEE Management**

The first Module addresses the following issues: the check-up of a production system, the operating status of a production plant, the availability of a productive resource, the potential productive, the production rate, the production capacity, the measurement of plant internal performance, the OEE measurement, the costs for decisions.

**Subject 2. Statistical Review**

The second Module addresses the following issues: descriptive, mathematical and inferential statistics. Types of random variables and probability distributions. Sample mean and variance. The standard normal distribution. The Central Limit Theorem, the Hypothesis Test, errors of I and II species, power of the Hypothesis Test, the characteristic operating curve and the confidence interval of means and variances.

**Subject 3. Quality Management**

The third Module addresses the following issues: the quality in production, natural and project tolerance, process capability indicators. The statistical methods for quality control: the 7 quality tools, the Control Charts, the Lot for Lot Acceptance Control. Quality certification and ISO 9001, quality costs and product regulations. The principles for development of total quality and the ideas developed by Tagushi.

**Subject 4. Design of Experiments**

The fourth Module addresses the following issues: introduction to the experimental design, definition of process variables and noise factors, guidelines for designing experiments, one-way variance analysis, two or more-way variance analysis, analysis

of residuals, $2^k$ factorial plans, regression models. The optimization of a production process, the response surface methodology, the path of maximum slope, first and second order models.

**Subject 5. Lean Production**
The fifth Module addresses the following issues: the principles of the Toyota Production System (TPS), the TPS application tools, the waste in production, the leveling of the Master Production Schedule (MPS), the Kanban system and its rules, the modeling of hypothesis of the Just In Time (JIT), the GCM approach.

## Evaluation system and criteria

The assessments of course is based on the following criteria:

I) **Final exam** (**85%** of grade):

The examination consists of a written test aimed for ascertaining the abilities to analyze and re-elaborate the studied concepts. The written test includes both numerical exercises and theory questions to be carried out in 90 minutes. The exercises present in the exams will cover the most applicative course modules and, in particular, will focus on Experimental Design, Quality and OEE Management. The topics of the theory questions, on the other hand, may concern all the subjects of the course (except the Subject 2-bis "Statistical Review").

Forms and/or notes are not permitted for the written test. Any tables necessary for the resolution of the exercises are provided by the instructor within the text.

II) **E-Tivities** (**15%** of grade):

The final grade will be obtained by mediating the mark of the written test (with a weight of 85%), with that of series of interactive activities, called E-Tivities (with instead a weight of 15%). So, the overall evaluation of E-Tivities has a maximum score of 4,5 points on the final grade. They must be sent to the instructor before the written test: in absence of delivery, a null vote will be applied in the final count. For the development of the II E-Tivity, a tutorial about the application of the SW Minitab®, to optimize a production process, is available.

## Bibliography and resources

4. *Materials to consult*

- *R.B. Chase, F.R. Jacobs, N.J. Aquilano - "Operations Management for Competitive Advantage", McGraw-Hill/Irwin, 11th edition (2006).*

- *Douglas C. Montgomery – "Statistical Quality Control: A Modern Introduction", John Wiley & Sons, 7th edition International (2012).*
- *Douglas C. Montgomery – "Design and Analysis of Experiments", John Wiley & Sons, 8th edition International (2012).*
- *John Nicholas – "Lean Production for Competitive Advantage: A Comprehensive Guide to Lean Methodologies and Management Practices", Productivity Press, 2nd edition (2018).*

5. *Recommended bibliography*

   *Other suggested readings are:*

- *J.A. De Feo, J.M. Juran - "Juran's Quality Handbook: The complete guide to performance excellence", McGraw-Hill, 7th edition (2016).*
- *Wallace J. Hopp, Mark L. Spearman - "Factory Physics: Foundations of Manufacturing Management", 3rd edition (2008).*
- *Eliyahu M. Goldratt, Jeff Cox, David Whitford - "The Goal: A Process of Ongoing Improvement - 30th Annniversary edition" (2014).*