



| Teaching Guide | | | | |
|--------------------------|---|--------|--|---------|
| Identifying Data | | | | 2023/24 |
| Subject (*) | Statistical Quality Control | Code | 614493114 | |
| Study programme | Mestrado Universitario en Técnicas Estadísticas (Plan 2019) | | | |
| Descriptors | | | | |
| Cycle | Period | Year | Type | Credits |
| Official Master's Degree | 2nd four-month period | First | Optional | 5 |
| Language | Spanish | | | |
| Teaching method | Hybrid | | | |
| Prerequisites | | | | |
| Department | Matemáticas | | | |
| Coordinador | Tarrio Saavedra, Javier | E-mail | javier.tarrio@udc.es | |
| Lecturers | Naya Fernandez, Salvador Tarrio Saavedra, Javier | E-mail | salvador.naya@udc.es javier.tarrio@udc.es | |
| Web | | | | |
| General description | The statistical quality control is the branch of statistics connected with the industry and companies that includes all the technics and statistical methodologies developed for the maintenance and improvement of the quality of the processes that involve products and services. Between the most used technics, there are the control charts, the analysis of the capability of processes, all those tools related with the design of experiments and the models of reliability. | | | |

| Study programme competences / results | |
|---------------------------------------|---|
| Code | Study programme competences / results |
| A16 | CE1 - Coñecer, identificar, modelar, estudar e resolver problemas complexos de estatística e investigación operativa, nun contexto científico, tecnolóxico ou profesional, xurdidos en aplicacións reais. |
| A17 | CE2 ? Desenvolver autonomía para a resolución práctica de problemas complexos surtidos en aplicación reais e para a interpretación dos resultados cara á axuda na toma de decisións. |
| A18 | CE3 - Adquirir coñecementos avanzados dos fundamentos teóricos subxacentes ás distintas metodoloxías da estatística e a investigación operativa, que permitan o seu desenvolvemento profesional especializado. |
| A19 | CE4 - Adquirir as destrezas necesarias no manexo teórico-práctico da teoría de probabilidade e as variables aleatorias que permitan o seu desenvolvemento profesional no eido científico/académico, tecnolóxico ou profesional especializado e multidisciplinar. |
| A20 | CE5 - Profundizar no coñecemento dos fundamentos teórico-prácticos especializados de modelado e estudo de distintos tipos de relacións de dependencia entre variables estatísticas. |
| A21 | CE6 - Adquirir coñecementos teórico-prácticos avanzados de distintas técnicas matemáticas, orientadas especificamente á axuda na toma de decisións, e desenvolver a capacidade de reflexión para avaliar e decidir entre distintas perspectivas en contextos complexos. |
| A23 | CE8 - Adquirir coñecementos teórico-prácticos avanzados das técnicas destinadas á realización de inferencias e contrastes relativos a variables e parámetros dun modelo estatístico, e saber aplicalos con autonomía suficiente nun contexto científico, tecnolóxico ou profesional. |
| A25 | CE10 - Adquirir coñecementos avanzados sobre metodoloxías para a obtención e o tratamento de datos derivados de distintas fontes, como enquisas, internet, ou entornos "na nube". |
| B1 | CB6 - Posuír e comprender coñecementos que acheguen unha base ou oportunidade de ser orixinais no desenvolvemento e/ou aplicación de ideas, a miúdo nun contexto de investigación |
| B2 | CB7 - Que os estudantes saiban aplicar os coñecementos adquiridos e a súa capacidade de resolución de problemas en ámbitos novos ou pouco coñecidos dentro de contextos máis amplos (ou multidisciplinares) relacionados coa súa área de estudo |
| B3 | CB8 - Que os estudantes sexan capaces de integrar coñecementos e enfrontarse á complexidade de formular xuízos a partir dunha información que, sendo incompleta ou limitada, inclúa reflexións sobre as responsabilidades sociais e éticas vinculadas á aplicación dos seus coñecementos e xuízos |
| B4 | CB9 - Que os estudantes saiban comunicar as súas conclusións e os coñecementos e razóns últimas que as sustentan a públicos especializados e non especializados dun modo claro e sen ambigüidades |
| B5 | CB10 - Que os estudantes posúan as habilidades de aprendizaxe que lles permitan continuar estudando dun modo que habrá de ser en gran medida autodirixido ou autónomo. |



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| B17 | CG1 - Coñecer, comprender e saber aplicar os principios, metodoloxías e novas tecnoloxías na estatística e a investigación operativa en contextos científico/académicos, tecnolóxicos ou profesionais especializados e multidisciplinares, así como adquirir as destrezas e competencias descritas nos obxectivos xerais do título. |
| B18 | CG2 - Desenvolver autonomía para identificar, modelar e resolver problemas complexos da estatística e da investigación operativa en contextos científico/académicos, tecnolóxicos ou profesionais especializados e multidisciplinares. |
| B19 | CG3 - Desenvolver a capacidade para realizar estudos e tarefas de investigación e transmitir os resultados a públicos especializados, académicos e xeneralistas. |
| B20 | CG4 - Integrar coñecementos avanzados e enfrontarse á toma de decisións a partir de información científica e técnica. |
| B21 | CG5 - Desenvolver a capacidade de aplicación de algoritmos e técnicas de resolución de problemas complexos no eido da estatística e a investigación operativa, manexando o software especializado axeitado. |
| C11 | CT1 - Desenvolver firmes capacidades de razoamento, análise crítica e autocrítica, así como de argumentación e de síntese, contextos especializados e multidisciplinares. |
| C12 | CT2 - Desenvolver destrezas avanzadas no manexo de Tecnoloxías da Información e a Comunicación (TIC), tanto para a obtención de información como para a difusión do coñecemento, nun ámbito científico/académico, tecnolóxico ou profesional especializado e multidisciplinar. |
| C13 | CT3 - Ser capaz de resolver problemas complexos en novos escenarios mediante a aplicación integrada dos coñecementos. |
| C14 | CT4 - Desenvolver unha sólida capacidade de organización e planificación do estudo, asumindo a responsabilidade do seu propio desenvolvemento profesional, para a realización de traballos en equipo e de xeito autónomo. |
| C15 | CT5 - Desenvolver capacidades para o aprendizaxe e a integración no traballo en equipos multidisciplinares, nos ámbitos científico/académico, tecnolóxico e profesional. |

| Learning outcomes | | | |
|--|---------------------------------------|------|------|
| Learning outcomes | Study programme competences / results | | |
| Know the basics of statistical quality control. | AC16 | BJ1 | CJ11 |
| | AC18 | BJ3 | CJ13 |
| | AC19 | BJ5 | CJ14 |
| | AC20 | BJ17 | |
| | AC21 | BJ18 | |
| | AC23 | BJ20 | |
| | AC25 | | |
| Know how to communicate the results of statistical quality control to a not specialized audience in business contexts. | | BJ4 | CJ15 |
| | | BJ19 | |
| Know the specific software for quality control and be autonomous in its management. | AC17 | BJ2 | CJ12 |
| | | BJ21 | |

| Contents | |
|---|---|
| Topic | Sub-topic |
| 1. Introduction to quality control. | <ul style="list-style-type: none"> a) Brief historical review of quality control. b) State of the art and new challenges. c) Quality control in the era of Big Data and Industry 4.0. d) Presentation and motivation of real problems of statistical process control. |
| 2. Basic concepts of statistical quality control. | <ul style="list-style-type: none"> a) Assignable and non-assignable causes. b) The seven tools of Isikawa. c) Deming and Juran's philosophy of quality assurance. d) Metrology and statistical process control. e) Introduction to Six Sigma Methodology. |



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| 3. Methods and philosophy of control charts. | <ul style="list-style-type: none">a) Control charts and hypothesis testing.b) Risks of the seller and buyer.c) Rational subgroups.d) Analysis of patterns in a control chart. |
| 4. Manufacturing control by variables. | <ul style="list-style-type: none">a) Limits of tolerance and capacity of the process.b) Shewhart type graphs by variables.c) Operating characteristic curve (OC) and mean streak length (ARL) in the control by variables.d) Optimization of control charts.e) Exercises. |
| 5. Manufacturing control by attributes. | <ul style="list-style-type: none">a) Manufacturing control by the non-conforming fraction.b) Graphs np and p. Control charts c and u.c) Characteristic curves in the control by attributes.d) Selection between control by variables and attributes.e) Exercises. |
| 6. Capability analysis of a process. | <ul style="list-style-type: none">a) Study of capability using histograms and control charts.b) Determination of the natural limits of tolerance and its impact on capability.c) Basic capability indices and comparative study.d) Exercises. |
| 7. Other univariate control charts. | <ul style="list-style-type: none">a) CUSUM charts.b) Weighted Average Control Charts (EWMA).c) Statistical alternatives to control charts. Philosophy of Engineering Process Control and Precontrol. |
| 8. Multivariate Control Charts. | <ul style="list-style-type: none">a) Description of a multivariate process control problem.b) Hotelling T2 charts.c) Multivariate MEWMA chart.d) Use of alternative multivariate techniques: PCA and non-parametric charts based on "data depth".e) Exercises. |
| 9. Reception control | <ul style="list-style-type: none">a) Statistical foundations of sampling plans.b) Attribute sampling plan.c) Variable sampling plan.d) Sequential controls.e) Characteristic curve for a sampling plan.f) Acceptable quality level and average output quality.g) MIL-STD-105 and MIL-STD-414 standards and their corresponding extensions (ANSI / ASQC / ISO).h) Exercises. |
| 10. Introduction to industrial reliability. | <ul style="list-style-type: none">a) Relationship between reliability and quality.b) Type of data and models for industrial reliability.c) Accelerated life tests (AFT) and models for degradation. |
| 11. Design of experiments to improve quality and reliability. | <ul style="list-style-type: none">a) Factorial designs and response surfaces.b) Examples of application of designs used in process control.c) Exercises and practical cases. |
| 12. Software for quality control and reliability | <ul style="list-style-type: none">a) qcr R library for quality control.b) Other R libraries for quality and reliability control.c) ILS library and interlaboratory designs for Quality Control.c) Practical and practical examples with the ILS package. |



| Methodologies / tests | Competencies / Results | Teaching hours (in-person & virtual) | Student?s personal work hours | Total hours |
|--------------------------------|---|--------------------------------------|-------------------------------|-------------|
| ICT practicals | A17 A21 A23 A25 B2 B21 C12 C13 C14 C15 | 7 | 10.5 | 17.5 |
| Objective test | B2 B3 B17 | 2 | 0 | 2 |
| Guest lecture / keynote speech | A16 A18 A19 A20 A21 A23 A25 B1 B3 B17 B20 C11 | 20 | 56.5 | 76.5 |
| Seminar | A17 A20 B18 B19 | 4 | 10.5 | 14.5 |
| Supervised projects | B3 B4 B5 B18 B19 | 1 | 12.5 | 13.5 |
| Personalized attention | | 1 | 0 | 1 |

(*)The information in the planning table is for guidance only and does not take into account the heterogeneity of the students.

| Methodologies | |
|--------------------------------|--|
| Methodologies | Description |
| ICT practicals | Interactive practice sessions using computer tools, where teachers will support and supervise the implementation of the knowledge acquired by the students. Different statistical packages that the student must know and use (mainly belonging to the R statistical software) will be used for their correct application in statistical quality control. |
| Objective test | It will be carried out by means of a written test-type exam on basic concepts studied in the course. This test will score 40% of the final grade. |
| Guest lecture / keynote speech | Expository sessions, in which concepts and / or procedures will be presented, providing basic information necessary to understand a theoretical perspective or a practical procedure, also promoting student participation. |
| Seminar | Practical classes with exercises and / or group tutorials to solve the doubts that may arise in the development of teaching and that have not been resolved in the remaining face-to-face sessions. |
| Supervised projects | Autonomous learning activities, in which teachers will guide the completion of individual work by students. In exceptional cases, due to the difficulty and multidisciplinary nature of the task, this learning may be collaborative, in which the teachers will coordinate the performance of group work. Those students who wish to present a supervised work related to this subject, will be provided with a specific topic and its corresponding advice. There is also the possibility for students to propose a topic to the teachers of the subject. |

| Personalized attention | |
|---|--|
| Methodologies | Description |
| Guest lecture / keynote speech Seminar ICT practicals | In the master classes, debate between students and between students and the teacher will be encouraged at all times. In order to solve problems, it will be important to personally attend to the students in the event of any doubts that may arise. This attention will also serve, on the one hand, to the teacher to detect possible problems in the methodology used to teach the subject and, on the other, to the students to consolidate theoretical knowledge and to express their concerns about the subject. Personalized attention to the student during ICT practical classes will also be essential, especially until they become familiar with the statistical software to be used. |

| Assessment | | | |
|----------------|--|---|---------------|
| Methodologies | Competencies / Results | Description | Qualification |
| Objective test | B2 B3 B17 | Se propondrá unha proba escrita tipo test sobre conceptos básicos estudados no curso. | 40 |
| ICT practicals | A17 A21 A23 A25 B2 B21 C12 C13 C14 C15 | Realizaranse prácticas con paquetes estatísticos. | 60 |



Assessment comments

First chance:

The delivery of two works related to the application of tools of Statistical Quality Control to real or simulated data using the R statistical software will be requested (the evaluation of these works will correspond to 60% of the global mark). In order to perform these tasks, the methodologies taught in practical classes through ICT will be applied. The other 40% of the global score will be evaluated by submitting a final project that can involve the following topics: (1) to review and extend the various subjects taught in the subject, or (2) to program in R any Statistical Quality Control methodology, or (3) to perform a practical application of the knowledge and skills acquired in class to a real or simulated case study, or even (4) to perform a work of bibliographic analysis (reference articles related to the subject) or software linked to this field of statistics. The student who does not present the aforementioned work, may alternatively take the final exam (test type test of between 15 and 20 questions). The exam could be performed face-to-face, in the MTE classrooms or at distance using Microsoft Teams and/or Moodle applications. In the case of students with recognition of part-time dedication and academic exemption from attendance exemption who decides not to attend classes, they will be evaluated on both occasions as the rest of the students who are in a similar situation.

Second chance: The same evaluation procedure will be applied as in the first opportunity.

Sources of information

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|----------------------|---|
| Basic | <ul style="list-style-type: none"> - Juran J. y Godfrey B. (2001). Manual de Calidad (tomos I y II).. McGrawHill. - Carot V. (1998). Control estadístico de la Calidad. . Edita Universidad Politécnica de Valencia - Box, G.E.P. y Luceño A. (1997). Statistical Control by Monitoring and Feedback Adjustment.. Wiley. New York. - Montgomery D. (2009). Introduction to Statistical Quality Control. . Wiley &&& Sons - Meeker W. y Escobar L. (1998). Statistical Methods for Reliability Data. . Wiley &&& Sons. - ILS paquete de R (2016). Librería ILS. https://cran.r-project.org/web/packages/ILS/ILS.pdf - GE, Zhiqiang; SONG, Zhihuan. (2012). Multivariate statistical process control: Process monitoring methods and applications.. Springer Science & Business Media. - Cano, E. L., Moguerza, J. M., & Redchuk, A. (2012). Six sigma with R: statistical engineering for process improvement (Vol. 36). . Springer Science & Business Media - Flores, M., Fernández-Casal, R., Naya, S., & Tarrío-Saavedra, J. (2021). Statistical Quality Control with the qcr Package. The R Journal |
| Complementary | |

Recommendations

Subjects that it is recommended to have taken before

- Probability Models/614493001
- Applied Statistics/614493002
- Exploratory Data Analysis/614493004

Subjects that are recommended to be taken simultaneously

- Multivariate Analysis/614493012
- Time Series/614493123

Subjects that continue the syllabus

Other comments



The development of the contents of the subject will be carried out taking into account that the competences to be acquired by the students must meet the MECES3 level. In this sense, all the contents of the subject will be studied exhaustively, presenting all the statistical tools for statistical quality control in a rigorous way, including those multivariate and functional techniques that represent new trends in this field, of application for solving problems in the framework of Industry 4.0. In cases of fraudulent performance of exercises or tests, the provisions of the respective regulations of the universities participating in the Master on Statistical Techniques will be applied. This guide and the criteria and methodologies described therein are subject to modifications derived from regulations and directives of the universities participating in the Master on Statistical Techniques. To help to achieve a sustainable environment and meet the objective of action number 5: "Healthy and sustainable environmental and social teaching and research" of the "Green Campus Ferrol Action Plan":

- 1.- The delivery of the documentary works carried out in this subject:
 - 1.1. It will be requested in virtual format and/or computer support.
 - 1.2. It will be done through Moodle, in digital format without the need to print them.
 - 1.3. If done on paper:
 - Plastics will not be used.
 - Double-sided prints will be made.
 - Recycled paper will be used.
 - Draft printing will be avoided.
- 2.- A sustainable use of resources and the prevention of negative impacts on the natural environment must be made.
- 3.- The importance of ethical principles related to the values of sustainability in personal and professional behavior must be taken into account.
- 4.- As it is included in the different regulations of application for university teaching, the gender perspective must be incorporated in this subject (non-sexist language will be used, bibliography of authors of both sexes will be used, intervention in student class will be encouraged and students...).
- 5.- We will work to identify and modify prejudices and sexist attitudes, and the environment will be influenced to modify them and promote values of respect and equality.
6. Situations of discrimination based on gender must be detected and actions and measures will be proposed to correct them.
7. The full integration of students who, due to physical, sensorial, psychic or sociocultural reasons, experience difficulties in an ideal, egalitarian and profitable access to university life will be facilitated

(*)The teaching guide is the document in which the URV publishes the information about all its courses. It is a public document and cannot be modified. Only in exceptional cases can it be revised by the competent agent or duly revised so that it is in line with current legislation.