UNIVERSIDADE DA CORUÑA

Teaching Guide				
Identifying Data				2020/21
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 of processes, all those tools related with the design of experiments and the models of reliability.			
Contingency plan	1. Changes in content The contents will not be modified. 2. Methodologies Teaching methodologies that are maintained The teaching methodologies set out in this guide will be used regardless of the degree of attendance under which the subject is taught, understanding face-to-face classes those carried out from the videoconference classroom, while the non-face-to-face evening classes those carried out through programs such as Microsoft Teams . Teaching methodologies that are modified No teaching methodology is modified. 3. Mechanisms for personalized attention to students Tools: Microsoft Teams and email. Temporalization: Microsoft Teams will be used during class hours, in addition to tutoring hours. E-mail will serve as a means to resolve doubts and to exchange files and information in general. 4. Modifications in the evaluation Likewise, the CEC assessment procedure will not need any type of modification, since the alternative of having it done entirely from the delivery of work by the students is already provided. Assessment remarks: The delivery of two practical works related to the application of tools with 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), following the methodologies taught in practical classes through ICT. The other 40% of the overall grade will correspond to the final exam of the subject (it would be carried out by telematic means in synchronous mode), a test of between 15 and 20 questions. As an alternative to the exam, the student may be evaluated from the other 40% of the overall grade by submitting a final paper that may be (1) review and extension of the various subjects taught in the subject, or (2) programming in R of some Statistical Quality Control methodology, or (3) of the practical application of the knowledge imparted to a real or simulated case study, or even (4) a bibliographic analysis work (reference articles related to the subject) or software linked to this field of statistics. Second chance: The same evaluation procedure will be applied as in the first opportunity. 5. Modifications of the bibliography or webgraphy			

Study programme competences

Code	Study programme competences
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 surdidos 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 específicamente 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 fuentes, 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 haberá de ser en gran medida autodirixido ou autónomo.
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 objectivos generales 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 multidisciplinais.
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 desenvovemento 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 multidisciplinais, nos ámbitos científico/académico, tecnolóxico e profesional.

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

Contents	
Topic	Sub-topic
1. Introduction to quality control.	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.	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.
3. Methods and philosophy of control charts.	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. Variable manufacturing control.	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.	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.	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.	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.	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	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.	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.	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	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.

Planning				
Methodologies / tests	Competencies	Ordinary class hours	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	3	0	3
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	7	10.5	17.5
Supervised projects	B3 B4 B5 B18 B19	1	9.5	10.5
Personalized attention		0		0
(*)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 multidisciplinarity 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 laboratory practical classes will also be essential, especially until they become familiar with the statistical software to be used.

Assessment			
Methodologies	**Competencies**	**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 estatisticos.	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 orther 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 adquired 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

Basic	- 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 - qcr paquete de R (2016). Librería qcr (Quality Control Review). https://cran.r-project.org/web/packages/qcr/index.html - GE, Zhiqiang; SONG, Zhihuan. (2012). Multivariate statistical process control: Process monitoring methods and applications.. Springer Science & Business Media.
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.