UNIVERSIDADE DA CORUÑA

Teaching Guide			
Identifying Data			2023/24
Subject (*)	Evaluation and Optimization of the Energy System Sustainability	Code	730547019d
Study programme	Máster Universitario en Eficiencia Enerxética e Sustentabilidade (a distancia)		

Descriptors				
Cycle	Period	Year	Type	Credits
Official Master's Degree	2nd four-month period	First	Optional	3

Language	SpanishGalicianEnglish		
Teaching method	Non-attendance		
Prerequisites			
Department	Ciencias da Navegación e Enxeñaría MariñaEnxeñaría Civil		
Coordinador	Caño Gochi, Alfredo del	E-mail	alfredo.cano@udc.es
Lecturers	Caño Gochi, Alfredo del	E-mail	alfredo.cano@udc.es
	Cartelle Barros, Juan José		juan.cartelle1@udc.es
Web	https://moodle.udc.es/my/		
General description	Basic concepts. Assessment of environmental, social and economic sustainability, and its application to electricity production. Optimisation methods in engineering and its application to simple energy systems.		

Study programme competences / results	
Code	Study programme competences / results
A4	CE4 - Apply data analysis methods for the creation of efficient energy systems
B1	CB6 - Possess and understand knowledge that provides a foundation or opportunity to be original in the development and/or application of ideas, often in a research context
B2	CB7 - That students know how to apply the knowledge acquired and their ability to solve problems in new or little-known environments within broader (or multidisciplinary) contexts related to their area of study
B3	CB8 - That students are able to integrate knowledge and face the complexity of formulating judgments based on information that, being incomplete or limited, includes reflections on the social and ethical responsibilities linked to the application of their knowledge and judgments
B6	CG1 - Search and select alternatives considering the best possible solutions
B7	CG2 - Develop analysis and synthesis skills; encourage critical discussion, defending arguments, and drawing conclusions
B10	CG5 - Boost creativity
B16	CG11 - Evaluate the application of emerging technologies in the field of energy and the environment
C2	CT2 - Master the oral and written expression and comprehension of a foreign language
C3	CT3 - Use the basic tools of information and communication technologies (ICT) necessary for the exercise of their profession and for learning throughout their lives
C4	CT4 - Develop for the exercise of a respectful citizenship with the democratic culture, human rights and the gender perspective

Learning outcomes			
Learning outcomes	Study programme competences / results		
To know the main existing methods for sustainability assessment. To be able to apply them by using existing commercial software applications.	AC4	BC1 BC2 BC3 BC6 BC7 BC10 BC16	CC2 CC3 CC4

To know the main methods for optimization in engineering. To be able to design simple models of sustainable energy systems aimed to their optimization.	AC4	BC1 BC2 BC3 BC6 BC7 BC10 BC16	CC2 CC3 CC4

Contents	
Topic	**Sub-topic**
Os bloques ou temas seguintes desenvolven os contidos establecidos na ficha da Memoria de Verificación.	Contido da ficha da Memoria de Verificación.
Assessing and optimizing the sustainability of energy systems.	Basic concepts. Sustainable development, sustainability. Assessment and optimization of sustainability in engineering: state of the art. Main methods for assessing sustainability. Useful computer applications. Case study: assessing the sustainability of renewable and non-renewable power plants. Optimization methods in engineering. Useful computer applications. Sustainability models of simple energy systems and its optimization. Conceptual framework, models and methods.

Planning				
Methodologies / tests	**Competencies / Results**	**Teaching hours (in-person & virtual)**	**Student?s personal work hours**	**Total hours**
Guest lecture / keynote speech	A4 B1 B6 B7 B10 B16 C2 C3 C4	10	15	25
Case study	A4 B1 B2 B3 B6 B7 B10 B16 C2 C3 C4	9	34	43
Objective test	A4 B1 B2 B3 B6 B7 C2	2	0	2
Personalized attention		5	0	5
(*)The information in the planning table is for guidance only and does not take into account the heterogeneity of the students.				

Methodologies	
Methodologies	**Description**
Guest lecture / keynote speech	Oral presentation (using audiovisual material and student interaction) designed to transmit knowledge and encourage learning. Presentations of this type are variously referred to as ?expository method?, ?guest lectures? or ?keynote speeches?. (The term ?keynote? refers only to a type of speech delivered on special occasions, for which the lecture sets the tone or establishes the underlying theme; it is characterised by its distinctive content, structure and purpose, and relies almost exclusively on the spoken word to communicate its ideas). These lectures will be offered through videos for asynchronous use.
Case study	Teaching-learning method in which students are presented with a specific set of real-life circumstances and a problem (?case?) which they must attempt to understand, assess and solve either as an individual or as a group. Students should be able to analyse a series of facts relating to a particular area of knowledge or activity, and arrive at a rational conclusion or numerical result, individually, or via a process of discussion within small work groups. These lectures will be offered through videos for asynchronous use.

Objective test	Students who complete all compulsory coursework (case studies) will only have an oral or written defence of their coursework, in the form of short or multiple choice questions. Students who do not complete the compulsory coursework will have an exam covering the whole subject matter, which may include long questions, short questions, multiple choice questions, exercises, and case studies. In both cases, students who wish to do so may take the objective test in Ferrol, face to face, taking advantage of the opportunity to meet teachers and fellow students in person. In the case of virtual tests, an exam protocol will be used which will be communicated to the student sufficiently in advance. The student is responsible for obtaining the necessary means for this protocol. In any case, the student must have a computer with a webcam, a printer connected to the computer, and a mobile phone.

Personalized attention	
Methodologies	**Description**
Case study	Professors will help the student for solving theoretical or practical doubts. The personalized attention may be performed in the official schedules for that purpose, or in other moments but, in order to avoid unnecessary waiting time for the student, in either case, the date and time shall be agreed in advance through Email or telephone. The figures related to personalized attention in the Planning section are merely indicative.

Assessment			
Methodologies	**Competencies / Results**	**Description**	**Qualification**
Objective test	A4 B1 B2 B3 B6 B7 C2	See what has been said in this regard in the section on Methodologies.	40
Case study	A4 B1 B2 B3 B6 B7 B10 B16 C2 C3 C4	See what has been said in this regard in the section on Methodologies.	60

Assessment comments

Assessment and grading criteriaThere will be two types of coursework, one or more will be compulsory, and one will be optional. The compulsory coursework will account for 80% of the overall mark of the coursework, and the optional coursework will account for the rest (20%). In order to pass the subject it is sufficient to adequately complete the compulsory coursework, and to obtain 5 points out of 10 in the defence test, which may be oral and individual.The basic correction criteria are as follows:The score will be null if the answer or result of the calculation:- Include a misconception.- Do not include adequate justification of the decision taken or, in general, of the response requested (if such justification is requested).- Or they do not respect any of the essential requirements that the statement has established.- In the case of numerical results, if the result requested does not coincide with the one to be obtained (leaving possible rounding differences to the margin), or if the necessary detail of the operations carried out is not included, or if the calculation computer file used to carry out the exercise is not included.If the wording carried out by the student is not clear, can not be understood or is grammatically incorrect, the grade may even go down to zero points, if this wording is impossible to understand, or may give rise to misunderstandings, or may lead to the non-compliance of any of the essential requirements that the statement has established. Bear in mind that one of the missions of a graduate of this Master is to generate designs and give written orders for the appropriate work to be carried out; this implies the need to write correctly. It is key to generate documents that are easily intelligible, so that the other stakeholders could understand what is happening or what they have to do. This includes, among other things, that the student must write with correct spelling and syntax, and must always use the appropriate technical language, and not a colloquial one.In accordance with the UDC's internal policies and guidelines, work that is likely to lead to this problem will be analysed by means of an anti-plagiarism system. Software of this type does not work intelligently (e.g. it may consider the student's name or affiliation as plagiarism) and, therefore, the professor will evaluate the results of the analysis with due caution. Bearing this problem in mind, in general, any work with more than 25% of text considered as plagiarism by the software will not be accepted. It will be returned to the student, who will have to submit it with the problem solved at the next opportunity or, if it is the second opportunity, in the following course.The evaluation criteria are the same for the first and the second opportunity, including students with academic dispensation.In the event that the student applies for an early exam session, he/she must fulfil the same requirements as the other students, with sufficient time in advance to be eligible for this right, notifying the teacher sufficiently in advance so that he/she can make the necessary arrangements.In any case, always developing the topics to be taught and, therefore, fulfilling the teaching assignment within the framework established by the number of credits of the subject, the teacher has the right to Academic Freedom, as recognized by the Spanish Constitution, the Spanish Constitutional Court, the Spanish Organic Law of Universities, the Charter of Fundamental Rights of the European Union, and UNESCO. Obviously, the teacher must always act within the law, and must teach modern, current, and correct contents covering the entire scope defined by the curriculum.The Spanish Constitution (Art. 20) establishes respect for the Academic Freedom which, in its different definitions (e.g., Real Academia Española and Consejo General del Poder Judicial; https://dej.rae.es), implies the possibility of the professor to explain the subject in accordance with his or her own convictions, complying with the established syllabuses, and within the framework of the institutions responsible for organizing education, as long as they adequately exercise the corresponding responsibility. At the same time, Castillo Córdova (2006) includes in the Academic Freedom the faculty to choose the methodology that the professor considers most appropriate to transmit the knowledge.The latter means that the aspects of this guide corresponding to the teaching methods to be used, and the percentage of hours to be devoted to each of them, are merely tentative, for guidance, and the teacher will be able to make changes if he / she considers it positive, being able to investigate whether there are better methodological approaches for teaching, such as some of those proposed in scientific literature or in specialized monographs on the subject (Felder and Brent, 2016), and always in favour of academic results.All of the above explained with respect to teaching methodologies will never negatively affect the mode of evaluation, in which the student will always be able to obtain the maximum grade regardless of his or her personal circumstances, in accordance with what is established in this evaluation section.Student responsibilities. The distance learning student must watch the videos of the lectures, study all the materials made available on the Virtual Campus, consult any doubts that may arise, and have all the appropriate material resources to be able to follow the course and be assessed.References-Castillo Córdova, Luis (2006). Libertad de Cátedra en la relación laboral con ideario. Valencia: Tirant lo Blanch. ISBN: 9788484565567- Felder, RM, Brent, R (2016), Teaching and learning STEM. USA: Jossey-Bass (Wiley).

Sources of information	
Basic	Apuntes e transparencias da materia, ao dispor do alumno en Moodle.Apuntes e transparencias da materia, ao dispor do alumno en Moodle.

Complementary	Sistemas enerxéticos? Bradford, T (2018). The Energy System: Technology, Economics, Markets, and Policy. USA: The MIT Press. ISBN: 9780262037525.? Hodge, BK (2017). Alternative Energy Systems and Applications. USA: John Wiley. ISBN: 9781119109211.? Jain, P (2016). Wind Energy Engineering. USA: McGraw-Hill Education. ISBN: 0071843841.? Jenkins, N, Ekanayake, J (2017). Renewable Energy Engineering. UK: Cambridge University Press. ISBN-10: 1107680220.? Kreith, F (2013). Principles of Sustainable Energy Systems. USA: CRC Press. ISBN: 9781466556966.? Messenger, RA, Abtahi, A (2017). Photovoltaic Systems Engineering. USA: CRC Press. ISBN: 9781498772778.? Pecher, A, Kofoed, JP (Editors) (2017). Handbook of Ocean Wave Energy. Switzerland: Springer. ISBN: 9783319398884.? Vanek, F, Albright, LD, Angenent, L (2016). Energy Systems Engineering: Evaluation and Implementation. USA: McGraw-Hill Education. ISBN: 1259585093.? Yan, Jinyue (Editor) (2015). Handbook of Clean Energy Systems (6 Volume Set). UK: John Wiley. ISBN: 9781118388587.Sustentabilidade e desenvolvemento sustentable.? United Nations. Our common future. World commission on environment and development. 1st ed. Oxford, UK: Oxford University Press; 1987, ISBN 978-0-19-282080-8. p. 416.? United Nations. The Rio declaration on environment and development [Internet]. In: The United Nations conference on environment and development (UNCED); 1992 June 3-14. Rio of Janeiro, Brazil.? Bouvier LF, Grant L. How many Americans?: population, immigration and the environment. San Francisco, CA, USA: Sierra Club Books; 1994, ISBN 978-0-87156-496-2.? Meadows D, Meadows D, Randers J. Limits to growth: the 30-year update. 3rd ed. White River Jct., VT, USA: Chelsea Green Publishing; 2004, ISBN 978-1-931498-58-6.Avaliación da sustentabilidade de centrais eléctricas renovables e non renovables. Métodos de avaliación da sustentabilidade.? Kaya T, Kahraman C. Multicriteria renewable energy planning using an integrated fuzzy VIKOR & AHP methodology: the case of Istanbul. Energy 2010; 35(6): 2517-27. ? Diakoulaki D, Karangelis F. Multi-criteria decision analysis and cost-benefit analysis of alternative scenarios for the power generation sector in Greece. Renew Sustain Energy Rev 2007; 11(4): 716-27.? Everett, B, Boyle, G, Peake, S, Ramage, J (Editors) (2012). Energy Systems and Sustainability: Power for a Sustainable Future. UK: Oxford University Press. ISBN: 0199593744.? Jovanovic M, Afgan A, Radovanovic P, Stevanovic V. Sustainable development of the Belgrade energy system. Energy 2009; 34(5): 532-9.? Kowalski K, Stagl S, Madlener R, Omann I. Sustainable energy futures: methodological challenges in combining scenarios and participatory multicriteria analysis. Eur J Operational Res 2009; 197(3): 1063-74.? Afgan NH, Carvalho MG. Multi-criteria assessment of new and renewable energy power plants. Energy 2002; 27(8): 739-55.? Afgan NH, Carvalho MG, Jovanovic M. Biomass-fired power plant: the sustainability option. Int J Sustain Energy 2007; 26(4): 179-93.? Begic F, Afgan NH. Sustainability assessment tool for the decision making in selection of energy systemdBosnian case. Energy 2007; 32(10): 1979-85.? Burton J, Hubacek K. Is small beautiful? A multi-criteria assessment of smallscale energy technology applications in local governments. Energy Policy 2007; 35(12): 6402-12.? Doukas HCh, Andreas BM, Psarras JE. Multi-criteria decision aid for the formulation of sustainable technological energy priorities using linguistic variables. Eur J Operational Res 2007; 182(2): 844-55.? Varun, Prakash R, Bhat IK. Energy, economics and environmental impacts of renewable energy systems. Renew Sustain Energy Rev 2009; 13(9): 2716-21.? Kahraman C, Kaya I, Cebi S. A comparative analysis for multiattribute selection among renewable energy alternatives using fuzzy axiomatic design and fuzzy analytic hierarchy process. Energy 2009; 34(10): 1603-16.? Dombi M, Kuti I, Balogh P. Sustainability assessment of renewable power and heat generation technologies. Energy Policy 2014; 67: 264-71. ? Gómez D, del Caño A, de la Cruz MP, Josa A. Metodología genérica para la evaluación de la sostenibilidad de sistemas constructivos. El método MIVES. In: Aguado A, editor. Sostenibilidad y construcción. Madrid, Spain: Asociación Científico-Técnica del Hormigón Estructural; 2012. p. 385-411.? de la Cruz MP, Castro A, del Caño A, Gómez D, Lara M, Cartelle JJ. Comprehensive methods for dealing with uncertainty in assessing sustainability. Part I: the MIVES e Monte Carlo method. In: García-Cascales MS, Sánchez-Lozano JM, Masegosa AD, Cruz-Corona C, editors. Soft computing applications for renewable energy and energy efficiency. Hershey, PA, USA: IGIGlobal; 2015, ISBN 978-1-4666-6631-3. p.69-p106.? Cartelle Barros JJ, et al., Assessing the global sustainability of different electricity generation systems. Energy 2015; 89(2015): 473-489.Métodos de optimización en enxeñaría. Optimización da sustentabilidade de sistemas enerxéticos.? B.D. Ripley, Stochastic simulation, Wiley & Sons, New York (1987).? C.A. Floudas and P.M. Pardalos, Encyclopedia of optimization, Springer, USA (2009).? F. Rothlauf, Design of modern heuristics: principles and application, Springer, Germany (2011).? R.L. Haupt and S.E. Haupt, Practical genetic algorithms, Wiley, Hoboken, New Jersey (2004).? A. Aboshosha and Y. Khalyfa, Genetic algorithms theories and applications, LAP Lambert, Saarbrücken, Germany (2012).? F. Glover, ?Tabu search: Part I?, in ORSA J Comput

1989, Vol. 1(3) pp. 190?260.? F. Glover, ?Tabu search: Part II?, in ORSA J Comput 1989, Vol. 2(1), pp. 4?32.? S. Kirkpatrick, C.D. Gelatt and M.P. Vecchi, ?Optimization by simulated annealing?, in Science 1983, Vol. 220(4598), pp. 671-680.? A. Dekkers and E.H. Aarts, ?Global optimization and simulated annealing?, In Mathematical Programming 1991, Vol. 50(3), pp. 367-393. ? Del Caño A, de la Cruz P, Cartelle JJ, Lara M, Conceptual framework for an integrated method to optimize sustainability of engineering systems. Journal of Energy and Power Engineering 9 (2015) 608-615.

Recommendations
Subjects that it is recommended to have taken before
Subjects that are recommended to be taken simultaneously
Subjects that continue the syllabus
Master Thesis/770523023
Other comments
SustainabilityFor helping to achieve a sustained environment and comply with the objective of the action number 5, ?Healthy and sustainable teaching and research?, of the ?Ferrol Green Campus Action Plan?, all must make a sustainable use of resources and prevent negative impacts on the natural environment.For this reason, the delivery of the course works performed in this subject will be made exclusively in electronic format. The student should not employ, in any case, physical material of any kind (paper, ink, binding, etc.).

(*)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.