UNIVERSIDADE DA CORUÑA

Teaching Guide			
Identifying Data			2019/20
Subject (*)	Evaluation and Optimization of the Energy System Sustainability	Code	770523020
Study programme	Mestrado Universitario en Eficiencia e Aproveitamento Enerxético		

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

Language	SpanishGalician		
Teaching method	Face-to-face		
Prerequisites			
Department	Ciencias da Navegación e Enxeñaría MariñaEnxeñaría Civil		
Coordinador	Lara Coira, Manuel	E-mail	manuel.lara.coira@udc.es
Lecturers	Caño Gochi, Alfredo del	E-mail	alfredo.cano@udc.es
	Lara Coira, Manuel		manuel.lara.coira@udc.es
Web	https://moodle.udc.es/my/		
General description	Knowledge of the life cycle of the main power generation systems. Study of technical and economic aspects. Analysis of different methods of assessing sustainability. Practical work with simple models of sustainability assessment. Introduction to engineering optimization methods.		

Study programme competences	
Code	Study programme competences
A11	Capacidad para aplicar métodos de análisis de datos para la creación de sistemas energéticos eficientes.
B1	Que los estudiantes sepan aplicar los conocimientos adquiridos y su capacidad de resolución de problemas en entornos nuevos o poco conocidos dentro de contextos más amplios (o multidisciplinares) relacionados con su área de estudio.
B2	Que los estudiantes sean capaces de integrar conocimientos y enfrentarse a la complejidad de formular juicios a partir de una información que, siendo incompleta o limitada, incluya reflexiones sobre las responsabilidades sociales y éticas vinculadas a la aplicación de sus conocimientos y juicios.
B3	Poseer y comprender conocimientos que aporten una base u oportunidad de ser originales en el desarrollo y/o aplicación de ideas, a menudo en un contexto de investigación.
B6	Buscar y seleccionar alternativas considerando las mejores soluciones posibles.
B7	Desarrollar las capacidades de análisis y síntesis; fomentar la discusión crítica, la defensa de argumentos y la toma de conclusiones.
B10	Potenciar la creatividad.
B16	Valorar la aplicación de tecnologías emergentes en el ámbito de la energía y el medio ambiente.
C2	Fomentar la sensibilidad hacia temas medioambientales.
C3	Aplicar una metodología que fomente el aprendizaje y el trabajo autónomo.
C4	Desarrollar el pensamiento crítico

Learning outcomes			
Learning outcomes	Study programme competences		
To know the main existing methods for sustainability assessment. To be able to apply them by using existing commercial software applications.	AJ11	BC1 BC2 BC6 BC7	CC2 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.		BC3 BC10 BC16	CC3

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	Ordinary class hours	Student?s personal work hours	Total hours
Guest lecture / keynote speech	B3 B7 B10 C2 C4	10	15	25
Case study	A11 B1 B2 B6 B16 C3	11	34	45
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.)
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.

Personalized attention	
Methodologies	Description
Case study	Professors will help the student for solving theoretical or practical doubts. The supervision sessions will take place be in the professsor's office, located in his center. 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	Description	**Qualification**
Case study	A11 B1 B2 B6 B16 C3	See what has been said in this regard in the section on Methodologies.	100

Assessment comments

In order to solve the problems of students with academic dispensation, or with coinciding class schedules, or with other problems that prevent attendance at class, such attendance is not compulsory.However, it is a fact that the probability of passing the subject and of obtaining a high grade increase with attendance and, therefore, attendance is recommended.There will be two types of coursework, one or more will be compulsory, and one will be optional. Compulsory courses will account for 60% of the overall grade, and optional courses will account for the rest.Part of the compulsory work will be carried out during class time, with the support of the teacher. Students who do not attend class must also do these works, consulting their doubts with the teacher.All students must defend their compulsory coursework.In order to overcome this defence, the teachers will ask the student questions, and the student will have to demonstrate that she/he has the necessary theoretical knowledge to really know what she/he has done with the computer during the development of the aforementioned work, and to interpret the results to which she/he has arrived. These questions may be asked either orally or in writing.All of the above refers to students who attend a minimum of 80% of the classes.In the case of students who attend less than 80% of the classes (which includes the academic dispensation), during the defense of compulsory work these students must also answer other questions on the rest of the syllabus, to analyze their real assimilation of the theoretical and practical concepts of the subject. These questions may be asked orally or in writing.The difference between distance Universities (e.g., the UNED; the Open University) and the rest of Universities is that, in the first ones, the University is responsible for contacting the students and providing them with all the materials necessary for passing the subject, by studying those materials. That is not the case of the rest of Universities, such as the UDC, in which the student is responsible for contacting the professors; downloading the materials contained in Moodle and working with them; attending the classes and taking notes on what it said by the professors; following the written and verbal instructions of the professor; and studying all the materials referred to, in order to pass the subject. The students who do not attend some classes (including the ones with exemption for attending the classes), have the same responsibilities as the rest of students, although in this case, since they are not attending the classes, they are responsible for getting in touch with peers and professors, aiming to collect all the teaching material that has been alluded.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.The evaluation criteria are the same for the first and the second opportunity.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.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
The students will respect the opportune punctuality, and they will not be able to enter in class after the beginning of the session, except in the case of practical sessions in which the students are working with the support of the professor.With current technology, the student is losing the ability to take notes (something necessary in the enterprise environment) and, on the other hand, tends to distraction when using electronic means to follow an explanation. Therefore, and despite the fact that this subject includes notes in Moodle for the whole subject, students will not be able to use computers, tablets or mobiles in class, while the teacher is making an explanation. In these moments the student must concentrate on the explanation and take handwritten, either as an element of study or as a complement to their electronic notes.For 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.).In addition, on demand, the professors and the University will facilitate the full integration of students that, having an adequate background to be able to pass the subject, may experience difficulties (physical, sensorial, psychological, socio-cultural) for a suitable, equal, and useful access to the university life.