Teaching Guide				
Identifying Data				2022/23
Subject (*)	Electric Drive		Code	770523011
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	SpanishGalicianEnglish			
Teaching method	Hybrid			
Prerequisites				
Department	Enxeñaría Industrial			
Coordinador		E-mail		
Lecturers		E-mail		
Web	campusvirtual.udc.gal/login/index.php			
General description	In this course the different drives of electrical machines , fundamentally different technologies to be used in AC machines are studied , identifying the advantages according to the processes and analyzing the necessary control systems , which are used in renewable energy , mainly in wind energy. It also is directed towards students interested in the technology of electric vehicles, both hybrid and fully electric, a real alternative to ordinary vehicles.			

Study programme competences / results	
Code	Study programme competences / results
A1	Análise e aplicación de metodoloxías e normativa para unha xestión eficiente da enerxía.
A2	Análisis e implantación de medidas de ahorro y eficiencia energética en los sectores industrial, terciario y residencial.
A4	Análisis de consumos energéticos y de su costes asociados.
A16	Capacidad para buscar, analizar, identificar y aplicar nuevas fuentes de energía eléctrica o nuevas técnicas de gestión de la electricidad bajo criterios como eficiencia, sostenibilidad o cooperación, así como el empleo de éstas sobre nuevas aplicaciones.
B9	Extraer, interpretar y procesar información, procedente de diferentes fuentes, para su empleo en el estudio y análisis.
B11	Adquirir nuevos conocimientos y capacidades relacionados con el ámbito profesional del máster.
B12	Analizar de forma crítica la propia experiencia de prácticas.
B13	Aplicar los conocimientos teóricos a la práctica
B16	Valorar la aplicación de tecnologías emergentes en el ámbito de la energía y el medio ambiente.
B17	Desarrollar la capacidad para asesorar y orientar sobre la mejor forma o cauce para optimizar los recursos energéticos en relación con las energías renovables.
B18	Plantear y resolver problemas, interpretar un conjunto de datos y analizar los resultados obtenidos; en el ámbito de la eficiencia energética y la sostenibilidad.
C2	Fomentar la sensibilidad hacia temas medioambientales.
C4	Desarrollar el pensamiento crítico
C5	Adquirir la capacidad para elaborar un trabajo multidisciplinar

Learning outcomes	
Learning outcomes	Study programme competences / results

Apply quantitative methods and computer programs to simulate and analyze control systems required for the design of electrical machines drives to solve engineering problems .	AJ1 AJ2 AJ4 AJ16	BC9 BC11 BC12 BC13 BC16 BC17 BC18	CC2 CC4 CC5
Investigate and define problems and identify possible restrictions in the analysis and design of electrical drives , using different technologies.	AJ2 AJ4 AJ16		CC4
Understanding the needs of user and consumer in the selection of drives required for different types of electrical machines.	AJ16	BC9 BC12 BC13	CC5
Use creativity to establish innovative solutions in the analysis and design of electrical machines drives , according to the different requirements .	AJ16	BC12 BC13	CC4 CC5
Knowing the different processes, products and services related to the design of electrical machines drives of computers. It is able to use technical literature and other sources of information.	AJ16	BC9 BC12 BC13 BC16 BC17 BC18	CC4
Have job skills laboratory and workshops.		BC11 BC12 BC13	CC4

Contents	
Topic	**Sub-topic**
1. Overview of Wind Turbines	-Classification of Wind Turbines. -Turbines of fixed, variable speed. Evaluation. -Power converted. Controls. -Types of turbines.
2. Induction machine	- Description and representation of Induction Machine. -Steady-State Model. Root Mean Square Values. Real and Reactive Powers. General Equivalent Circuit. Torque.
3. Synchronous Generator.	-Description of Synchronous machine. Salient Pole .Rotating Reference . Steady-State Model. Root Mean Square Values. Real and Reactive Powers. -Cylindrical Rotor Synchronous machine. Dynamic Model -Dynamics of Rotating Mass. Dynamics of Electrical Modes. Terminal Voltage Dynamics. Electric Torque Dynamics.
4. Type 1 Wind Turbine System.	-Equivalent Circuit for the Squirrel-Cage Induction Generator. Power Flow. Electric Torque. Maximum Power. Maximum Torque. -Assessment of Type 1 System. -Control and Protection of Type 1 System. Reactive Power of Type 1 System. Inrush Current. Turbine Stability.
5. Type 2 Wind Turbine System	Equivalent Circuit of Type 2 Generator. Real Power. Electric Torque. Assessment of Type 2 System. Control and Protection of Type 2 System. Inrush Current. Turbine Stability.

6. Type 3 Wind Turbine System	-Equivalent Circuit. -Simplified Model. -Power Flow. Apparent Power Flow through RSC. Apparent Power Flow through GSC. -Speed Control. -Protection of Type 3 Systems. Electrical Protection. Crowbar System. Chopper System. Electromechanical Protection. Stator Dynamic Resistance. Rotor Dynamic Resistance.
7. Type 4 Wind Turbine	-Full Converter. -Power Flow. -Real Power Control. - Reactive Power Control. -Protection. Chopper System. Dynamic Resistance
8. Electric Vehicle.	-Types. Asynchronous motor. Synchronous motor permanent magnet. -Electric. Hybrid . Plug-in hybrids. -Electric Vehicle: advantages and disadvantages, structure, batteries, motors, power converters.

Planning				
Methodologies / tests	Competencies / Results	Teaching hours (in-person & virtual)	Student?s personal work hours	Total hours
Guest lecture / keynote speech	A1 A2 A4 A16 B9 B11 B12 B13 B16 B17 B18 C2 C4 C5	9	30	39
Practical test:	A16 B12 B13 C5	12	7	19
Problem solving	A1 A2 A4 A16 B9 B11 B12 B13 B16 B17 B18 C2 C4 C5	0	12	12
Short answer questions	A1 A2 A4 A16 B9 B11 B12 B13 B16 B17 B18 C2	3	0	3
Personalized attention		2	0	2
(*)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	In-class activity in the classroom, or virtual through videoconference, the fundamentals of the subject are explained . Using multimedia means to facilitate learning.
Practical test:	It allows the evaluation of the projects prepared by the students, their skills, competences and acquired knowledge, in order to assess their ability to apply the knowledge and skills, promote their autonomous work, research capacity and search for reliable information.
Problem solving	The teacher makes standard problems , proposing solutions and providing resources to students.
Short answer questions	The student must answer various questions related to the course program, can use support material, in order to check the mastery of the content and the achievement of the objectives.

Personalized attention	
Methodologies	Description

Problem solving	The work done both in the laboratory and in the proposed problems is analyzed in order to focus on key points, proposed by the teacher. The students are required to explain or resolve any problems that may arise.be requirirá. Students doubts are resolved.

Assessment			
Methodologies	**Competencies / Results**	**Description**	**Qualification**
Short answer questions	A1 A2 A4 A16 B9 B11 B12 B13 B16 B17 B18 C2	Test carried out under the control of the teacher, where the student must answer various questions related to the program of the subject. Occasionally you can consult documentation, in order to check the mastery of academic content and the achievement of curricular objectives.	25
Problem solving	A1 A2 A4 A16 B9 B11 B12 B13 B16 B17 B18 C2 C4 C5	Students must solve various problems at the teacher's proposal, the student must reflect with critical thinking, identifying the needs and looking for the correct solutions and integrating the concepts acquired in the course.	30
Practical test:	A16 B12 B13 C5	It consists of the assessment of projects developed by the students, as well as the skills, competences and knowledge acquired with their preparation.	45

Assessment comments

Sources of information	
Basic	KRAUSE,P.C. ; WASYNCZUK, O.; SUDHOFF, S.D. Analysis of Electric Machinery and Drive Systems. Wiley-IEEE Press. March 5th 2002.KRISHNAN, R. Electric Motor Drives Modeling, Analysis, And Control. Prentice Hall,2001. WILDI, T. Máquinas Eléctricas y Sistemas de Potencia. México. Pearson Prentice Hall,2007. BOLDEA, I.; NASAR, S.A. Electric Drives, USA, CRC Press, 1999.
Complementary	

Recommendations
Subjects that it is recommended to have taken before
Subjects that are recommended to be taken simultaneously
Subjects that continue the syllabus
Other comments