UNIVERSIDADE DA CORUÑA

| Teaching Guide | | | | |
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| Identifying Data | | | | 2019/20 |
| 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 | Face-to-face | | | |
| Prerequisites | | | | |
| Department | Enxeñaría Industrial | | | |
| Coordinador | Chouza Gestoso, Jesus Diego | E-mail | jesus.chouza@udc.es | |
| Lecturers | Chouza Gestoso, Jesus Diego | E-mail | jesus.chouza@udc.es | |
| Web | https://moodle.udc.es/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.<br>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 | |
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| Code | Study programme competences |
| 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 | | | |
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| Learning outcomes | Study programme competences | | |
| 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<br>AJ2<br>AJ4<br>AJ16 | BC9<br>BC11<br>BC12<br>BC13<br>BC16<br>BC17<br>BC18 | CC2<br>CC4<br>CC5 |

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| Investigate and define problems and identify possible restrictions in the analysis and design of electrical drives , using different technologies. | AJ2<br>AJ4<br>AJ16 | | CC4 |
| Understanding the needs of user and consumer in the selection of drives required for different types of electrical machines. | AJ16 | BC9<br>BC12<br>BC13 | CC5 |
| Use creativity to establish innovative solutions in the analysis and design of electrical machines drives , according to the different requirements . | AJ16 | BC12<br>BC13 | CC4<br>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<br>BC12<br>BC13<br>BC16<br>BC17<br>BC18 | CC4 |
| Have job skills laboratory and workshops. | | BC11<br>BC12<br>BC13 | CC4 |

| Contents | |
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| **Topic** | **Sub-topic** |
| 1. Overview of Wind Turbines | -Classification of Wind Turbines.<br>-Turbines of fixed, variable speed. Evaluation.<br>-Power converted. Controls.<br>-Types of turbines. |
| 2. Induction machine | - Description and representation of Induction Machine.<br>-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.<br>-Cylindrical Rotor Synchronous machine. Dynamic Model<br>-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.<br>-Assessment of Type 1 System.<br>-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.<br>-Simplified Model.<br>-Power Flow. Apparent Power Flow through RSC. Apparent Power Flow through GSC.<br><br>-Speed Control.<br>-Protection of Type 3 Systems. Electrical Protection. Crowbar System. Chopper System. Electromechanical Protection.<br>Stator Dynamic Resistance. Rotor Dynamic Resistance. |

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| 7. Type 4 Wind Turbine | -Full Converter.<br>-Power Flow.<br>-Real Power Control.<br>- Reactive Power Control.<br>-Protection. Chopper System. Dynamic Resistance |
| 8. Electric Vehicle. | -Types. Asynchronous motor. Synchronous motor permanent magnet.<br>-Electric. Hybrid . Plug-in hybrids.<br>-Electric Vehicle: advantages and disadvantages, structure, batteries, motors, power converters. |

| Planning | | | | |
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| Methodologies / tests | Competencies | Ordinary class hours | 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 |
| Laboratory practice | 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 |
| Objective test | A1 A2 A4 A16 B11 C4 C5 | 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 | |
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| Methodologies | Description |
| Guest lecture / keynote speech | It is done in the classroom, the fundamentals of the subject are explained . Using multimedia means to facilitate learning. |
| Laboratory practice | They consist of case studies where the student must demonstrate the acquired theoretical knowledge. You perform necessary to pass the subject . |
| Problem solving | The teacher makes standard problems , proposing solutions and providing resources to students. |
| Objective test | Evaluation test to be held at the end of the course, in the corresponding official announcements, where the student must demonstrate the degree of learning in an objective manner . They consist of a number between 15 and 20 multiple choice questions , accompanied by 6 possible answers , where only one is correct , students must always justify the answer , this being an indispensable condition for the answer to be accepted as correct. |

| Personalized attention | |
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| Methodologies | Description |
| Problem solving<br>Laboratory practice | 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.<br>The students are required to explain or resolve any problems that may arise.be requirirá.<br>Students doubts are resolved. |

| Assessment | | | |
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| Methodologies | Competencies | Description | Qualification |
| Problem solving | A1 A2 A4 A16 B9 B11 B12 B13 B16 B17 B18 C2 C4 C5 | Performs a test when the subject reaches the middle, which will represent 25% of the final grade, provided that the student obtains 4.5 points of 10 in the objective test. This test is voluntary. | 25 |

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| Laboratory practice | A16 B12 B13 C5 | The successful completion of laboratory practices are essential to pass the subject.<br>The test laboratory practices account for 15 % of the final grade for the subject ,the student must exceed 4.5 points to 10 points in the objective test to pass the course. | 15 |
| Objective test | A1 A2 A4 A16 B11 C4 C5 | The objective test to be performed at the end in the corresponding official announcements, where the student must demonstrate the degree of learning in an objective manner. They consist of a number between 15 and 20 multiple choice questions, accompanied by 6 possible answers, where only one is correct, students must always justify the answer, this being an indispensable condition for the answer to be accepted as correct.<br>To pass the course the student must obtain 4.5 points of 10 in this test, will represent 60% of the final qualification. | 60 |

| Assessment comments |
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| Sources of information | |
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| 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 |
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| Subjects that it is recommended to have taken before |
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| Subjects that are recommended to be taken simultaneously |
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| Subjects that continue the syllabus |
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| Other comments |
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(*)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.