



## Teaching Guide

| Teaching Guide           |                                                                                                                                                                                                                                                                                                                                                          |       |            |                                                                                            |
|--------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------|------------|--------------------------------------------------------------------------------------------|
| Identifying Data         |                                                                                                                                                                                                                                                                                                                                                          |       | 2020/21    |                                                                                            |
| Subject (*)              | Solar Systems                                                                                                                                                                                                                                                                                                                                            |       | Code       | 770523002                                                                                  |
| Study programme          | Mestrado Universitario en Eficiencia e Aproveitamento Enerxético                                                                                                                                                                                                                                                                                         |       |            |                                                                                            |
| Descriptors              |                                                                                                                                                                                                                                                                                                                                                          |       |            |                                                                                            |
| Cycle                    | Period                                                                                                                                                                                                                                                                                                                                                   | Year  | Type       | Credits                                                                                    |
| Official Master's Degree | 1st four-month period                                                                                                                                                                                                                                                                                                                                    | First | Obligatory | 6                                                                                          |
| Language                 | Spanish                                                                                                                                                                                                                                                                                                                                                  |       |            |                                                                                            |
| Teaching method          | Face-to-face                                                                                                                                                                                                                                                                                                                                             |       |            |                                                                                            |
| Prerequisites            |                                                                                                                                                                                                                                                                                                                                                          |       |            |                                                                                            |
| Department               | Enxeñaría Industrial                                                                                                                                                                                                                                                                                                                                     |       |            |                                                                                            |
| Coordinador              | Meizoso López, María del Carmen                                                                                                                                                                                                                                                                                                                          |       | E-mail     | carmen.meizoso@udc.es                                                                      |
| Lecturers                | Graña Lopez, Manuel angel<br>Jove Pérez, Esteban<br>Meizoso López, María del Carmen<br>Zayas Gato, Francisco                                                                                                                                                                                                                                             |       | E-mail     | manuel.grana@udc.es<br>esteban.jove@udc.es<br>carmen.meizoso@udc.es<br>f.zayas.gato@udc.es |
| Web                      |                                                                                                                                                                                                                                                                                                                                                          |       |            |                                                                                            |
| General description      | The main objective of this course is to describe the technologies, regulations and future prospects of solar energy systems.                                                                                                                                                                                                                             |       |            |                                                                                            |
| Contingency plan         | 1. Modifications to the contents<br><br>2. Methodologies<br>*Teaching methodologies that are maintained<br><br>*Teaching methodologies that are modified<br><br>3. Mechanisms for personalized attention to students<br><br>4. Modifications in the evaluation<br><br>*Evaluation observations:<br><br>5. Modifications to the bibliography or webgraphy |       |            |                                                                                            |

## Study programme competences

| Code | Study programme competences                                                                                                                                                                                                              |
|------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| A6   | Capacidad para el diseño y análisis de sistemas de aprovechamiento solar.                                                                                                                                                                |
| A9   | Tener conocimiento de los fundamentos, potencial, tecnología, aplicaciones y normativa de fuentes de energía renovables.                                                                                                                 |
| A10  | Capacidad para analizar e incluir energías renovables en diferentes instalaciones.                                                                                                                                                       |
| A13  | Capacidad para analizar, aplicar y optimizar los sistemas de aprovechamiento energético.                                                                                                                                                 |
| 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. |
| B6   | Buscar y seleccionar alternativas considerando las mejores soluciones posibles.                                                                                                                                                          |
| B9   | Extraer, interpretar y procesar información, procedente de diferentes fuentes, para su empleo en el estudio y análisis.                                                                                                                  |
| 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.                                                                                                                                          |
| C2   | Fomentar la sensibilidad hacia temas medioambientales.                                                                                                                                                                                   |
| C3   | Aplicar una metodología que fomente el aprendizaje y el trabajo autónomo.                                                                                                                                                                |
| C6   | Dominar la expresión y la comprensión de un idioma extranjero.                                                                                                                                                                           |



| Learning outcomes                                                                                       |                             |                    |            |
|---------------------------------------------------------------------------------------------------------|-----------------------------|--------------------|------------|
| Learning outcomes                                                                                       | Study programme competences |                    |            |
| Assess the solar resource                                                                               | AJ6                         | BC9<br>BC13        | CC2<br>CC3 |
| Understand the thermal and photovoltaic solar systems, components and associated maintenance procedures | AJ9<br>AJ10<br>AJ13         | BC1<br>BC6<br>BC16 | CC6        |
| Knowing the regulations applicable to solar installations                                               |                             | BC9<br>BC16        |            |
| Assess the viability of solar installations                                                             |                             | BC13<br>BC16       |            |

| Contents                                       |                                                                                                                                                                                                          |
|------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Topic                                          | Sub-topic                                                                                                                                                                                                |
| Assess the solar resource                      | Movement of the Earth around the Sun.<br>Solar Time and Official Time<br>Relative movement of the Sun respect of a point on Earth<br>Solar radiation on a surface<br>Shading analysis                    |
| Photovoltaic technology                        | Solar cell<br>Photovoltaic module<br>Accumulation system<br>Charge controllers<br>Power Conditioning<br>Standalone photovoltaic systems<br>Grid-connected photovoltaic systems<br>Solar tracking systems |
| Solar thermal technologies for low temperature | Components<br>Thermal Collectors<br>Hydraulic system<br>Exchange system<br>Accumulation system<br>Control system<br>Calculating installation<br>Applicable regulations<br>Assessment of viability        |
| Solar thermal electricity technology           | Classification of solar systems<br>Concentration systems<br>Perspectives                                                                                                                                 |
| Solar fuels and biofuels                       | Hydrogen production<br>Biofuels generated by solar energy                                                                                                                                                |
| Regulations                                    | Key and additional references                                                                                                                                                                            |

| Planning                       |                 |                      |                               |             |
|--------------------------------|-----------------|----------------------|-------------------------------|-------------|
| Methodologies / tests          | Competencies    | Ordinary class hours | Student?s personal work hours | Total hours |
| Guest lecture / keynote speech | A9              | 14                   | 14                            | 28          |
| Laboratory practice            | A9 B9 B13       | 3                    | 1                             | 4           |
| Problem solving                | A9 B1 B6 B9 B13 | 19                   | 27                            | 46          |



|                                 |                                               |    |    |    |
|---------------------------------|-----------------------------------------------|----|----|----|
| Supervised projects             | A6 A9 A10 A13 B1 B6<br>B9 B13 B16 C2 C3<br>C6 | 0  | 40 | 40 |
| Oral presentation               | C6                                            | 6  | 6  | 12 |
| Field trip                      | A13 B13 B16 C2                                | 5  | 1  | 6  |
| Mixed objective/subjective test | A9 B1 B13 C2                                  | 2  | 2  | 4  |
| Personalized attention          |                                               | 10 | 0  | 10 |

(\*)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  | Revisaranse os contidos do temario durante as clases para expor os principais conceptos que permitan ao estudante a realización de problemas e traballos relacionados.                                                              |
| Laboratory practice             | Sesión de traballo no laboratorio con células solares e equipamento relacionado coa materia.                                                                                                                                        |
| Problem solving                 | Dedicaranse varias sesións presenciais á resolución de problemas ou supostos propostos con anterioridade.                                                                                                                           |
| Supervised projects             | Proporase a realización dun ou varios proxectos de instalación de enerxía solar, dos que haberá que presentar unha memoria e realizar unha exposición.                                                                              |
| Oral presentation               | Esta metodoloxía corresponde á exposición oral dos traballos realizados durante o curso.                                                                                                                                            |
| Field trip                      | Procurarase realizar algunha visita a instalacións que dispoñan de sistemas fotovoltaicos e/ou térmicos.                                                                                                                            |
| Mixed objective/subjective test | Ao final do cuadrimestre, nas datas determinadas polo calendario do Máster, realizarase unha proba obxectiva na que se avalíen os coñecementos adquiridos na materia. Poderá conter preguntas curtas ou de tipo test, ou problemas. |

| Personalized attention                                                    |                                                                                                           |
|---------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------|
| Methodologies                                                             | Description                                                                                               |
| Mixed objective/subjective test<br>Supervised projects<br>Problem solving | Teachers are available during tutorial sessions to address any questions that may arise along the course. |

| Assessment                      |                                               |                                                                                                                                                                                       |               |
|---------------------------------|-----------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------|
| Methodologies                   | Competencies                                  | Description                                                                                                                                                                           | Qualification |
| Mixed objective/subjective test | A9 B1 B13 C2                                  | Nas datas oficiais fixadas polo calendario do Máster realizárase unha proba mixta que pode incluír preguntas curtas, de tipo test ou cuestións relacionadas co temario da asignatura. | 30            |
| Supervised projects             | A6 A9 A10 A13 B1 B6<br>B9 B13 B16 C2 C3<br>C6 | Design of systems for real case studies                                                                                                                                               | 40            |
| Oral presentation               | C6                                            | Presentation of the supervised projects                                                                                                                                               | 20            |
| Field trip                      | A13 B13 B16 C2                                | If there is no posible to visit a solar power plant, the qualification of this activity is transferred to the objective test.                                                         | 10            |

| Assessment comments                                                                                                                                                                 |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| The 2nd chance evaluation will consist of the design of a system for real case studie (50%) and the objective test (50%). The final grade is the arithmetic mean of the two grades. |

| Sources of information |
|------------------------|
|------------------------|



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|----------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Basic</b>         | <ul style="list-style-type: none"><li>- Óscar Perpiñán, Manuel Castro y Antonio Colmenar (2012). Diseño de sistemas fotovoltaicos. Promotora General de Estudios S.A.</li><li>- Tobajas Vázquez, M. Carlos (2012). Montaje y mantenimiento de instalaciones solares térmicas : MF00601_2 : replanteo de instalaciones solares térmicas. Barcelona : Cano Pina</li><li>- Jutglar, Lluís (2012). Generación de energía solar fotovoltaica. Barcelona : Marcombo</li></ul>                                                                                                                                                                                                  |
| <b>Complementary</b> | <ul style="list-style-type: none"><li>- Zabalza Bribián, Ignacio (2009). Energía solar térmica. Zaragoza : Prensas Universitarias de Zaragoza</li><li>- Bayod Rújula, Ángel Antonio (2009). Sistemas fotovoltaicos. Zaragoza : Prensas Universitarias de Zaragoza</li><li>- International Energy Agency (2011). Solar energy perspectives (pp 161-169). Paris : OECD/IEA</li><li>- Fernández Salgado, José M<sup>a</sup> (2010). Compendio de energía solar: Fotovoltaica, térmica y termoeléctrica. Madrid: Mundi-Prensa</li><li>- Dufo López, Rodolfo (2005). Curso interactivo de energía solar fotovoltaica. Zaragoza : Prensas Universitarias de Zaragoza</li></ul> |

## 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

(\*)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.