



| Teaching Guide           |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |        |                                                  |           |
|--------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------|--------------------------------------------------|-----------|
| Identifying Data         |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |        | 2020/21                                          |           |
| Subject (*)              | Surface Treatments                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |        | Code                                             | 730497231 |
| Study programme          | Mestrado Universitario en Enxeñaría Industrial (plan 2018)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |        |                                                  |           |
| Descriptors              |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |        |                                                  |           |
| Cycle                    | Period                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | Year   | Type                                             | Credits   |
| Official Master's Degree | 1st four-month period                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         | Second | Optional                                         | 3         |
| Language                 | Spanish                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |        |                                                  |           |
| Teaching method          | Face-to-face                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |        |                                                  |           |
| Prerequisites            |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |        |                                                  |           |
| Department               | Enxeñaría Naval e Industrial                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |        |                                                  |           |
| Coordinador              | Amado Paz, José Manuel                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | E-mail | jose.amado.paz@udc.es                            |           |
| Lecturers                | Amado Paz, José Manuel<br>Tobar Vidal, María José                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | E-mail | jose.amado.paz@udc.es<br>maria.jose.tobar@udc.es |           |
| Web                      |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |        |                                                  |           |
| General description      | Study of processes, materials and technologies for surface modification of materials.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |        |                                                  |           |
| Contingency plan         | <p>1. Modifications to the contents</p> <p>The contents will be the same.</p> <p>2. Methodologies</p> <p>*Teaching methodologies that are maintained</p> <p>The same methodologies are maintained, except that it would not be possible to carry out laboratory practices and teaching would become online.</p> <p>*Teaching methodologies that are modified</p> <p>3. Mechanisms for personalized attention to students</p> <p>Moodle and Teams.</p> <p>4. Modifications in the evaluation</p> <p>Supervised jobs 80%</p> <p>Objective test 20%.</p> <p>*Evaluation observations:</p> <p>The evaluation will be done in the same way as indicated in the teaching guide except that the exam will be done online and there will be no practice.</p> <p>5. Modifications to the bibliography or webgraphy</p> |        |                                                  |           |

| Study programme competences |                                                                                                                                                                                                                                                                                     |
|-----------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Code                        | Study programme competences                                                                                                                                                                                                                                                         |
| B1                          | CB6 - Possess and understand knowledge that provides a basis 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 unfamiliar 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 making 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. |
| B4                          | CB9 - That the students know how to communicate their conclusions -and the knowledge and ultimate reasons that sustain them- to specialized and non-specialized audiences in a clear and unambiguous way.                                                                           |
| B5                          | CB10 - That students have the learning skills that allow them to continue studying in a way that will be largely self-directed or autonomous.                                                                                                                                       |



|     |                                                                                                                                                                                                                                                                 |
|-----|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| B6  | G1 - Have adequate knowledge of the scientific and technological aspects in Industrial Engineering.                                                                                                                                                             |
| B13 | G8 - Apply the knowledge acquired and solve problems in new or unfamiliar environments within broader and multidisciplinary contexts.                                                                                                                           |
| B14 | G9 - Be able to integrate knowledge and face the complexity of making judgments based on information that, being incomplete or limited, includes reflections on social and ethical responsibilities linked to the application of their knowledge and judgments. |
| B15 | G10 - Knowing how to communicate the conclusions -and the knowledge and ultimate reasons that sustain them- to specialized and non-specialized publics in a clear and unambiguous way.                                                                          |
| B16 | G11 - Possess the learning skills that allow to continue studying in a self-directed or autonomous way.                                                                                                                                                         |
| C1  | ABET (a) - An ability to apply knowledge of mathematics, science, and engineering.                                                                                                                                                                              |
| C2  | ABET (b) - An ability to design and conduct experiments, as well as to analyze and interpret data.                                                                                                                                                              |
| C3  | ABET (c) - An ability to design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability.                       |
| C6  | ABET (f) - An understanding of professional and ethical responsibility.                                                                                                                                                                                         |
| C7  | ABET (g) - An ability to communicate effectively.                                                                                                                                                                                                               |
| C8  | ABET (h) - The broad education necessary to understand the impact of engineering solutions in a global, economic, environmental, and societal context.                                                                                                          |
| C9  | ABET (i) - A recognition of the need for, and an ability to engage in life-long learning.                                                                                                                                                                       |
| C11 | ABET (k) - An ability to use the techniques, skills, and modern engineering tools necessary for engineering practice.                                                                                                                                           |

| Learning outcomes                                                                                            |  |                             |      |
|--------------------------------------------------------------------------------------------------------------|--|-----------------------------|------|
| Learning outcomes                                                                                            |  | Study programme competences |      |
| Know in a generic way the characteristics and applications of the different surface modification techniques. |  | BJ1                         | CJ2  |
|                                                                                                              |  | BJ2                         | CJ3  |
|                                                                                                              |  | BJ3                         | CJ6  |
|                                                                                                              |  | BJ4                         | CJ7  |
|                                                                                                              |  | BJ5                         | CJ8  |
|                                                                                                              |  | BJ6                         | CJ9  |
|                                                                                                              |  | BJ13                        | CJ11 |
|                                                                                                              |  | BJ14                        |      |
|                                                                                                              |  | BJ15                        |      |
|                                                                                                              |  | BJ16                        |      |
| To know in a specific way the technologies of deposition of protective coatings in metallic materials.       |  | BJ1                         | CJ1  |
|                                                                                                              |  | BJ2                         | CJ2  |
|                                                                                                              |  | BJ3                         | CJ3  |
|                                                                                                              |  | BJ4                         | CJ6  |
|                                                                                                              |  | BJ5                         | CJ7  |
|                                                                                                              |  | BJ6                         | CJ8  |
|                                                                                                              |  | BJ13                        | CJ9  |
|                                                                                                              |  | BJ14                        | CJ11 |
|                                                                                                              |  | BJ15                        |      |
|                                                                                                              |  | BJ16                        |      |
| Seleccionar las aleaciones más idóneas en función de sus propiedades funcionales.                            |  | BJ1                         | CJ1  |
|                                                                                                              |  | BJ2                         | CJ2  |
|                                                                                                              |  | BJ3                         | CJ3  |
|                                                                                                              |  | BJ4                         | CJ6  |
|                                                                                                              |  | BJ5                         | CJ7  |
|                                                                                                              |  | BJ13                        | CJ8  |
|                                                                                                              |  | BJ14                        | CJ9  |
|                                                                                                              |  | BJ15                        | CJ11 |
|                                                                                                              |  | BJ16                        |      |



| Contents                                                                                       |                                                                                                                                                                                                                     |
|------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Topic                                                                                          | Sub-topic                                                                                                                                                                                                           |
| The following chapters and topics develop the contents established in the Verification Report. | Surface modification techniques. Protective coatings: superalloys, light alloys, advanced materials.<br>Micromachining.<br>Biocompatibility.                                                                        |
| Coatings and alloys.                                                                           | Superalloys.<br>Light alloys.<br>Advanced materials.                                                                                                                                                                |
| Surface modification techniques.                                                               | Surface hardening.<br>Mechanical processes.<br>Thermal spray technologies.<br>Diffusion and implantation of ions.<br>Physical deposition.<br>Chemical deposition.<br>Electrochemical processes.<br>Liquid coatings. |
| Laser processing.                                                                              | Laser cladding.<br>Micromachining and texturing.<br>Cleaning.                                                                                                                                                       |
| Biocompatibility.                                                                              | Introduction to biocompatibility.<br>Biocompatible materials.                                                                                                                                                       |

| Planning                                                                                                                        |                                                           |                      |                               |             |
|---------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------|----------------------|-------------------------------|-------------|
| Methodologies / tests                                                                                                           | Competencies                                              | Ordinary class hours | Student's personal work hours | Total hours |
| Guest lecture / keynote speech                                                                                                  | B1 B13 B14 B16 B6<br>C1 C2 C6 C11                         | 14                   | 28                            | 42          |
| Laboratory practice                                                                                                             | B1 B2 B3 B5 B13 B14<br>B6 C3                              | 5                    | 11                            | 16          |
| Supervised projects                                                                                                             | B1 B2 B3 B4 B5 B13<br>B15 B14 B16 C1 C2<br>C3 C6 C7 C8 C9 | 1                    | 11                            | 12          |
| Objective test                                                                                                                  | B1 B2 B3 B4 C1 C11                                        | 1                    | 2                             | 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 | Oral presentation complemented with the use of audiovisual media and the introduction of some questions addressed to students, in order to transmit knowledge and facilitate learning.                                                                                                                                                                                                                                                                                        |
| Laboratory practice            | Methodology that allows students to learn effectively through the realization of practical activities, such as demonstrations, exercises, experiments and research.                                                                                                                                                                                                                                                                                                           |
| Supervised projects            | Methodology designed to promote the autonomous learning of students, under the tutelage of the teacher and in varied scenarios (academic and professional). It is referred primarily to the learning of "how to do things." It is an option based on the assumption by students of the responsibility for their own learning. This teaching system is based on two basic elements: the independent learning of the students and the monitoring of that learning by the tutor. |
| Objective test                 | Written test used to evaluate learning.                                                                                                                                                                                                                                                                                                                                                                                                                                       |

|                        |
|------------------------|
| Personalized attention |
|------------------------|



| Methodologies                              | Description                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
|--------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Supervised projects<br>Laboratory practice | <p>Student with full dedication:</p> <p>la) Laboratory practices: Resolution of doubts during the practice sessions.</p> <p>b) Supervised projects : Monitoring the work of the student during the development of the proposed supervised projects.</p> <p>Part-time students:</p> <p>la) Laboratory practices: Resolution of doubts during the practice sessions.</p> <p>b) Supervised projects: Monitoring the work of the student during the development of the proposed supervised projects.</p> |

| Assessment          |                                                           |                                                                                                                |               |
|---------------------|-----------------------------------------------------------|----------------------------------------------------------------------------------------------------------------|---------------|
| Methodologies       | Competencies                                              | Description                                                                                                    | Qualification |
| Supervised projects | B1 B2 B3 B4 B5 B13<br>B15 B14 B16 C1 C2<br>C3 C6 C7 C8 C9 | Projects done by the student.                                                                                  | 70            |
| Laboratory practice | B1 B2 B3 B5 B13 B14<br>B6 C3                              | Practices carried out by the student.                                                                          | 10            |
| Objective test      | B1 B2 B3 B4 C1 C11                                        | The objective test consists of passing a final exam that includes all the contents seen throughout the course. | 20            |

| Assessment comments                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <p>The final test will cover all the contents of the subject.</p> <p>Attendance at the laboratory is mandatory and must be done during the first year of enrollment. The practice note will be maintained. Unjustified faults are not allowed.</p> <p>Second opportunity will be evaluated on the same terms as the first opportunity.</p> <p>The students with recognition of part-time dedication according to the "Standard that regulates the regime of dedication to the study of the students of Degree in the UDC" will have to put it in knowledge of the coordinator of the subject. The evaluation will be carried out in the same terms as that of full-time students. The possible academic exemption of class attendance exemption will not be applicable in the laboratory practices, which must attend compulsorily and at the established time, as well as the corresponding final exam.</p> |

| Sources of information |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |
|------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Basic</b>           | <ul style="list-style-type: none"> <li>- Cartier, Michael (coordinator) (2003). Handbook of Surface Treatments and Coatings. . Professional Engineering Publishing Limited.</li> <li>- (2004). Handbook of Thermal Spray Technology.. ASM International.</li> <li>- Toyserkani, Ehsan (2002). Laser cladding.. CRC Press.</li> <li>- Schaaf, Peter (editor) (2010). Laser processing of materials : fundamentals, applications and developments.. Springer.</li> <li>- Misawa, Hiroaki (editor) (2006). 3D laser microfabrication : principles and applications.. Wiley-VCH.</li> <li>- Phipps, Claude R. (editor) (2007). Laser ablation and its applications.. Springer.</li> </ul> |
| <b>Complementary</b>   |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |

| 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

To help achieve a sustained immediate environment and comply with the objective of action number 5: "Healthy and sustainable environmental and social teaching and research" of the "Green Campus Ferrol Action Plan": The delivery of the documentary works that are made in this matter: They will be requested in virtual format and / or in computer support. Delivery will be made through Moodle, in digital format without the need to print them. If it is necessary to make them on paper: No plastics will be used. Double-sided prints will be made. Recycled paper will be used. The printing of drafts will be avoided. A sustainable use of resources and the prevention of negative impacts on the natural environment must be made.

(\*) 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.