ANX-PR/CL/001-01

LEARNING GUIDE

SUBJECT

43000613 - Materiales Para Condicones Extremas

DEGREE PROGRAMME

04AN - Master Universitario En Ingenieria De Materiales

ACADEMIC YEAR & SEMESTER

2023/24 - Semester 2

Index

Learning guide

1. Description

1.1. Subject details

Name of the subject	43000613 - Materiales para Condicones Extremas
No of credits	3 ECTS
Type	Optional
Academic year ot the programme	First year
Semester of tuition	Semester 2
Tuition period	February-June
Tuition languages	English
Degree programme	04AN - Master Universitario en Ingenieria de Materiales
Centre	04 - Escuela Tecnica Superior De Ingenieros De Caminos, Canales Y Puertos
Academic year	2023-24

2. Faculty

2.1. Faculty members with subject teaching role

Name and surname	Office/Room	Email	Tutoring hours *
Elena Maria Tejado Garrido (Subject coordinator)	ETSI Caminos	elena.tejado@upm.es	Tu - 11:00 - 13:00 Tu - 15:00 - 18:00 W - 11:00 - 13:00 W - 15:00 - 17:00 Students may agree on a more convenient date/hour by contacting by email: elena.tejado@upm.

			es
Jose Ygnacio Pastor Caño	ETSI Caminos	jy.pastor@upm.es	Tu - 13:00 - 19:00 Make an appointment request by e-mail: jy.pastor@upm.es

* The tutoring schedule is indicative and subject to possible changes. Please check tutoring times with the faculty member in charge.

2.2. Research assistants

Name and surname	Email	Faculty member in charge
Orellana Barrasa, Jaime	jaime.orellana@upm.es	Pastor Caño, Jose Ygnacio
Tarancon Roman, Sandra	sandra.tarancon@upm.es	Pastor Caño, Jose Ygnacio

2.3. External faculty

Name and surname	Email	Institution
Teresa Palacios García	teresa.palacios@upm.es	ETSI de Minas y Energía

3. Prior knowledge recommended to take the subject

3.1. Recommended (passed) subjects

- Properties Of Materials

3.2. Other recommended learning outcomes

- Structure of the matter

- Physics and chemistry

- Materials Science and Engineering

- Manufacturing technologies

- Ceramic Materials

4. Skills and learning outcomes *

4.1. Skills to be learned

CE1 - Capacidad para aplicar los fundamentos científicos del comportamiento físico y químico de los materiales para relacionar causalmente sus propiedades fundamentales físicas y químicas con su comportamiento macroscópico y el de los productos con ellos realizados / Ability to apply the scientific foundations of the physical and chemical behavior of materials to correlate their fundamental physical and chemical properties with their macroscopic behavior and that of the products made with them.

CE3 - Capacidad de diseñar, modelizar, evaluar, seleccionar, fabricar y utilizar materiales con propiedades específicas (estructurales y funcionales) para satisfa

CE4 - Autonomía para adquirir, analizar, actualizar y aplicar nuevos conocimientos, modelos y técnicas experimentales y numéricas en relación con la composición y estructura de los materiales, su caracterización física y química, sus procesos de fabricación, su utilización y aplicación científica y tecnológica, y su reciclado, reutilización y eliminación / Autonomy to acquire, analyze, update and apply new knowledge, models and experimental and numerical techniques related to the composition and structure of materials, their physical and chemical characterization, their manufacturing processes, their use and scientific and technological application, and their recycling, reuse and disposal

CE5 - Capacidad para planificar, explotar y gestionar técnicamente la selección, fabricación, procesado, utilización, reciclado, reutilización y eliminación de materiales, de forma respetuosa con el medio ambiente, de conformidad con la legislación nacional e internacional, y promoviendo el desarrollo sostenible y el bienestar de la sociedad / Ability to technically plan, exploit and manage the selection, manufacturing, processing, use, recycling, reuse and disposal of materials, in an environmentally friendly manner, in accordance with national and international legislation, and promoting sustainable development and well-being of the society

CG1 - Uso de la lengua inglesa: Los alumnos son capaces de transmitir conocimientos y expresar ideas y argumentos de manera clara, rigurosa y convincente, tanto de forma oral como escrita, adaptándose a las características de la situación y de la audiencia / Use of the English Language: Students are able to transmit knowledge and express ideas and arguments in a clear, rigorous and convincing manner, both orally and in writing, adapting to the characteristics of the situation and the audience .

CG7 - Uso de las TIC: Los alumnos son capaces de aplicar conocimientos tecnológicos necesarios de manera que les permitan desenvolverse cómodamente y afrontar los retos que la sociedad les va a imponer en su quehacer profesional empleando la informática / Use of ICT: Students are able to apply the necessary technological knowledge in a way that allows them to function comfortably and face the challenges that society is going to impose on them in their professional work using computers.

4.2. Learning outcomes

RA13 - Knowledge and understanding of how radiation affect the behaviour of materials.

RA14 - Knowledge and basic fabrication methods, structure and properties of refractory materials

RA12 - Knowledge and understanding of how extreme temperatures affect the behaviour of materials.

RA15 - Know, understand and correlate the behavior of materials under different environments with their structure, properties, processing and applications.

* The Learning Guides should reflect the Skills and Learning Outcomes in the same way as indicated in the Degree Verification Memory. For this reason, they have not been translated into English and appear in Spanish.

5. Brief description of the subject and syllabus

5.1. Brief description of the subject

Course description

Structural materials play an essential role in many applications, from aeroplane fuselage to car chassis, to computer and cell phone cases. Advanced applications often require materials that are stronger and lighter, as illustrated by the current development in carbon composites and nickel-base alloys.

Furthermore, these materials often operate under harsh environments where they have to maintain their high performance. Turbine blades in jet engines, for instance, operate close to their melting point in an oxidative environment; structural and cladding materials in nuclear reactors are subjected to radiation and corrosion. Besides, limits on material behaviour are among the greatest technical obstacles to improving the safety and economic performance of nuclear energy systems. Next-generation fast fission reactors and future fusion devices will need to overcome even more severe materials challenges, including high atomic displacement rates together with proton/helium production in the fast neutron spectrum. The need to develop materials that can perform well in these severe operating environments is a major challenge for materials science and requires a fundamental

understanding of material response under extreme conditions of radiation flux, temperature, and stress.

In contrast, there are other materials whose field of application is that of extremely low temperatures, since only there do they exhibit such interesting properties as superconductivity.

This course will review basic concepts, which underpin how the material behaves under extreme thermal and mechanical conditions as well as high-energy irradiations. The emphasis is made on qualitative description, providing basic science background, and avoiding unnecessary mathematical formalism. Engineering materials that can withstand hush environments and new materials with unique compositions/microstructures will be surveyed.

Course topics

The course will be roughly divided into four sections, as indicated in the Course Syllabus:

1. Refractory ceramic materials
2. Composites for extreme in-service applications
3. Metals under extreme in-service conditions, i.e. irradiation environments.
4. Materials for low-temperature applications, i.e. Superconductors

5.2. Syllabus

1. REFRACTORY CERAMIC MATERIALS

1.1. Refractory materials

1.1.1. Introduction to refractory ceramic science

1.1.2. Feedstock for refractory ceramic materials production

1.1.3. Main properties of refractory ceramic materials

1.1.4. Fabrication processes of refractory ceramic materials

1.2. Main refractory ceramic materials

1.2.1. Classifications of refractory ceramic materials

1.2.2. Refractory lining

1.3. Refractory ceramic materials today

3.2.4. Recent advances in SC production

3.3. Superconductor materials III:

3.3.1. Laboratory practice on the Meissner Effect in SC materials

4. MATERIALS SUBJECTED TO RADIATION ENVIRONMENTS

4.1. Basics of radiation effects

4.2. Selection of materials for nuclear power plants

4.3. Effect of irradiation on the mechanical properties

6. Schedule

6.1. Subject schedule*

Week	Classroom activities	Laboratory activities	Distant / On-line	Assessment activities
1	**Presentation of the subject, introduction** Duration: 02:00 Lecture			
2	**Refractory ceramic materials 1** Duration: 02:00 Lecture			
3	**Refractory ceramic materials 2** Duration: 02:00 Lecture			
4	**Refractory ceramic materials 3** Duration: 02:00 Lecture			
5	**Refractory ceramic materials 4** Duration: 02:00 Lecture			
6	**Advanced Refractory Materials 1** Duration: 02:00 Lecture			
7				**Partial examination 1** Online test Continuous assessment Presential Duration: 02:00
8	**Metals for extreme-in service operation 1** Duration: 02:00 Lecture			
9	**Metals for extreme-in service operation 2** Duration: 02:00 Lecture			
10	**Composites for extreme in-service applications 1** Duration: 02:00 Lecture			
11	**Composites for extreme in-service applications 2** Duration: 02:00 Lecture			
12	**Composites for extreme in-service applications 3** Duration: 02:00 Lecture			

13	**Materials for low-temperature applications, Superconductors 1** Duration: 02:00 Lecture			
14	**Materials for low-temperature applications, Superconductors 2** Duration: 02:00 Lecture			
15		**Materials for low-temperature applications, Superconductors 3** Duration: 02:00 Laboratory assignments		
16				**Partial examination 2** Online test Continuous assessment Presential Duration: 02:00
17				**Final regular examination** Online test Final examination Presential Duration: 02:00

Depending on the programme study plan, total values will be calculated according to the ECTS credit unit as 26/27 hours of student face-to-face contact and independent study time.

* The schedule is based on an a priori planning of the subject; it might be modified during the academic year, especially considering the COVID19 evolution.

7. Activities and assessment criteria

7.1. Assessment activities

7.1.1. Assessment

Week	Description	Modality	Type	Duration	Weight	Minimum grade	Evaluated skills
7	Partial examination 1	Online test	Face-to-face	02:00	50%	5 / 10	CG1 CG7 CE1 CE3 CE4 CE5
16	Partial examination 2	Online test	Face-to-face	02:00	50%	5 / 10	CG1 CG7 CE1 CE3 CE4 CE5

7.1.2. Global examination

Week	Description	Modality	Type	Duration	Weight	Minimum grade	Evaluated skills
17	Final regular examination	Online test	Face-to-face	02:00	100%	5 / 10	CG1 CG7 CE1 CE3 CE4 CE5

7.1.3. Referred (re-sit) examination

Description	Modality	Type	Duration	Weight	Minimum grade	Evaluated skills

Final extraordinary examination	Online test	Face-to-face	02:00	100%	5 / 10	CG1 CG7 CE1 CE3 CE4 CE5

7.2. Assessment criteria

Within the *PROGRESSIVE EVALUATION* system, the following assignments need to be completed:

1. Attendance and active participation in more than 70% of classes

2. Completion of two written tests, i.e., partial tests, (1 h duration each) regarding the theoretical contents of the Subject. Each partial exam comprises 50% of the total grade.

- Each partial exam will consist of up to 40 scoring questions equally scored, where each question will have multiple choice answers. An incorrect answer invalidates the question, even if any correct answer has been marked but does not subtract from other questions. Each correct answer to a question gives a proportionate share of the mark for that question based on the number of correct answers in the questionnaire. The exam will last a maximum of 60 minutes and, although submitted via Moodle, must be completed in class.

- The content of the subject included in each partial exam will be considered released if the grade obtained on the exam is higher than 5 out of 10.

3.- Proposition of exam-like questions. Each student will propose at least two questions per topic/session. This will add up to 1 point (proportional to the number of questions proposed) to the final grade, only if the Subject is already passed (i.e. total grade higher than 5 over 10).

Within the *FINAL EVALUATION* system, a Final Exam which will include all the contents of the subject, determines 100 % of the final grade, no additional points will be added for the proposition of questions.

8. Teaching resources

8.1. Teaching resources for the subject

Name	Type	Notes
Moodle	Web resource	Moodle platform
Lecture notes	Bibliography	Lecture Notes available on Moodle
Questions Bank	Web resource	Students are encouraged to suggest their own Exam Questions in a Moodle database.
Specialized papers	Bibliography	Specialized scientific and technical articles on the topics covered by the Subject will be provided to students via Moodle
Materials Under Extreme Conditions, Vincenzo Schettino and Roberto Bini, Imperial College Press, winter 2012	Bibliography	
https://www.northrefractories.com/	Web resource	
https://www.valoref.com/secondary-raw-materials	Web resource	
Ceramic Matrix Composites by Chawla K.K. (2019) In: Composite Materials. Springer, Cham.	Bibliography	
Ultra-High Temperature Ceramics: Materials for Extreme Environment Applications. Editor(s): William G. Fahrenholtz, Eric J. Wuchina,William E. Lee, Yanchun Zhou, 2014, DOI:10.1002/9781118700853	Bibliography	
Fundamental aspects of and Failure modes in High-Temperature composites (NASA), Christos D. Chamis and Carol A. Ginty, Lewis Research Center Cleveland, Ohio	Bibliography	

Advances in oxidation and ablation resistance of high and ultra high temperature ceramics modified or coated carbon/carbon composites, Journal of the European Ceramic Society 38 (2018) 1?28	Bibliography	Journal article
Introduction to Superconductivity (Second Edition) by Michael Tinkham	Bibliography	For the coverage of basic superconductivity; it is a classic text and covers most completely the topics in the course concerning basic superconductivity
Solid State Physics by Ashcroft and Mermin	Bibliography	Useful chapters in standard Solid State textbooks:
Bardeen J, Cooper LN, Schrieffer JR. Theory of superconductivity. Phys Rev 1957; 108(5):1175-1204	Bibliography	Journal Article, i.e. the famous paper that established the "BCS" theory of superconductivity and earned the authors a Nobel Prize
Superconduction.org website	Web resource	Good explanations of superconductivity and the latest news about room temperature superconductors and other advances in the field

9. Other information

9.1. Other information about the subject

Although not formally included in the Course Syllabus, this subject will introduce students to national and international policies related to the 2030 Agenda and its 17 accompanying Sustainable Development Goals (SDGs) in a transversal manner, with special attention to the following SDGs:

1. Ensuring inclusive and equitable quality education and promoting lifelong learning opportunities for all

2. Achieve gender equality and empower all women and girls.

4. Ensure access to affordable, reliable, sustainable, and modern energy for all

6. Develop resilient infrastructure, promote inclusive and sustainable industrialization, and encourage innovation

7. Reduce inequalities between and within countries.

9. Ensure sustainable consumption and production patterns

10. Take urgent action to combat climate change and its effects.

Teaching and evaluation activities within the subject will be moved online if necessary for health reasons.