ANX-PR/CL/001-01

LEARNING GUIDE

SUBJECT

45000129 - Soft Matter

DEGREE PROGRAMME

04MI - Grado En Ingenieria De Materiales

ACADEMIC YEAR & SEMESTER

2025/26 - Semester 1

Index

Learning guide

1. Description

1.1. Subject details

Name of the subject	45000129 - Soft Matter
No of credits	6 ECTS
Type	Compulsory
Academic year ot the programme	Third year
Semester of tuition	Semester 5
Tuition period	September-January
Tuition languages	English
Degree programme	04MI - Grado en Ingenieria de Materiales
Centre	04 - E.T.S. De Ing. De Caminos Canales Y P.
Academic year	2025-26

2. Faculty

2.1. Faculty members with subject teaching role

Name and surname	Office/Room	Email	Tutoring hours *
Rafael Daza Garcia		rafael.daza@upm.es	Sin horario.
Jose Perez Rigueiro (Subject coordinator)		jose.perez@upm.es	- -
Morten Andreas Geday		morten.geday@upm.es	Sin horario.

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

3. Prior knowledge recommended to take the subject

3.1. Recommended (passed) subjects

- Biología

- MecÁnica De Materiales I

- MecÁnica De Materiales Ii

3.2. Other recommended learning outcomes

The subject - other recommended learning outcomes, are not defined.

4. Skills and learning outcomes *

4.1. Skills to be learned

CE 2. - Saber modelizar el comportamiento (mecánico, electrónico, químico o biológico) de los materiales y su integración en componentes y dispositivos.

CE 7. - Saber diseÃ±ar, desarrollar y controlar los procesos de producciÃ³n y transformaciÃ³n de materiales

CE 8. - Saber diseÃ±ar y gestionar la utilizaciÃ³n y durabilidad de componentes y dispositivos con materiales, con especial cuidado en el deterioro de materiales y siendo respetuosos con el medio ambiente

CG 11 - Responsabilidad y ética profesional

CG 2 - Capacidad de trabajo en equipo

CG 3 - Comunicación oral y escrita

CG 9 - Capacidad de trabajo interdisciplinar

4.2. Learning outcomes

RA33 - Conocer los principios de funcionamiento y organizativos de los materiales blandos y del material celular. Conocer la dinámica de las interacciones débiles y los mecanismos de autoensamblaje. Conocer y saber predecir la respuesta a campos eléctricos y magnéticos y su interacción con las tensiones de origen mecánico.

RA34 - Utilizar con soltura la comunicación oral y escrita

RA35 - Saber trabajar en equipo en entornos interdisciplinares. Ejecutar el trabajo con responsabilidad y respeto a los demás.

RA64 - Entender, asimilar y manejar los conceptos básicos que describen el comportamiento químico y biológico de los materiales en su interacción con el entorno. Conocer y saber relacionar dicho comportamiento con la estructura del material y su jerarquización a diferentes escalas atómico, molecular y macroscópico.

RA65 - Conocer y saber calcular mediante las teorías más relevantes la degradación y corrosión química y biológica de los materiales. Conocer y saber aplicar las técnicas de protección y durabilidad.

* 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

The main objective is to provide the student with the necessary knowledge in the field of Soft Matter, including biological materials, biomimetic systems and liquid crystals.

IF NECESSARY FOR SANITARY REASONS, THE TEACHING AND GRADING ACTIVITIES WILL BE PERFORMED ONLINE.

5.2. Syllabus

1. Proteins. Composition. Structure. Molecular architecture of collagen

2. Introduction to complex systems. Self-cleaning surfaces and hydrophobic interaction. Order and disorder in complex systems

3. Statistical description of macromolecules. Diatomic and Polyatomic molecules. Collective excitations

4. Self-assembly: Sickle-cell anemia. Thermodynamics of self-assembly. Elastomers

5. Lipids. Composition. Self-assembly in micelles and bilayers

6. Adsorption on surfaces. Thermodynamics of adsorption. Biomineralization. Biocompatibility

7. Non-equilibrium thermodynamics. Membrane potential

8. Nonequilibrium kinetics. Reaction kinetics. Brownian movement. Fluctuation-dissipation theorem

9. Viscoelasticity. Experimental characterization. Microscopic origin

10. Liquid crystals. Types of liquid crystals. Physical properties

11. Electrooptical properties. Molecular reorientation. Light polarization. circular and linear retarders

12. Associated technology. Liquid crystals cells. Processing. Electrooptical response. Dynamic response

13. Displays. Addressing. Multiplexing. Optical switches. Tunable lenses and prims

6. Schedule

6.1. Subject schedule*

Week	Type 1 activities	Type 2 activities	Distant / On-line	Assessment activities
1	**Proteins. Composition. Structure. Molecular architecture of collagen** Duration: 04:00 Lecture			
2	**Introduction to complex systems. Self cleaning surfaces and hydrophobic interaction. Order and disorder in complex systems** Duration: 04:00 Lecture			
3	**Statistical description of macromolecules. Diatomic and polyatomic molecules. Collective excitations** Duration: 04:00 Lecture			
4	**Self-assembly: Sickle cell anemia. Thermodynamics of self-assembly** Duration: 04:00 Lecture			
5	**Lipids. Composition. Self-assembly in micelles and bilayers** Duration: 04:00 Lecture			
6	**Adsorption on surfaces. Thermodynamics of adsorption** Duration: 04:00 Lecture			
7	**Biomineralization. Biocompatibility** Duration: 04:00 Lecture			
8	**Nonequilibrium thermodynamics. Membrane potential** Duration: 04:00 Lecture			
9	**Nonequilibrium kinetics. Reaction kinetics** Duration: 04:00 Lecture			
10	**Brownian movement. Fluctuation-dissipation theorem. Viscoelasticity: experimental characterization** Duration: 04:00 Lecture			

11	**Viscoelasticity: Microscopic model** Duration: 02:00 Lecture			**Exam on Biomimetics** Written test Progressive assessment Presential Duration: 02:00
12	**Liquid crystals. Types of liquid crystals. Physical properties** Duration: 04:00 Lecture			
13	**Electrooptical properties. Molecular reorientation. Light polarization. Circular and linear retarders** Duration: 04:00 Lecture			
14	**Associated technology. Liquid crystals cells. Processing. Electrooptical response. Dynamic response** Duration: 04:00 Lecture			
15	**Displays. Addressing. Multiplexing. Optical switches.** Duration: 04:00 Lecture			
16	**Tunable lenses and prims** Duration: 02:00 Lecture			**Exam on Liquid crystals** Written test Progressive assessment Presential Duration: 02:00
17				**Final exam** Written test Global examination Not 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.

7. Activities and assessment criteria

7.1. Assessment activities

7.1.1. Assessment

Week	Description	Modality	Type	Duration	Weight	Minimum grade	Evaluated skills
11	Exam on Biomimetics	Written test	Face-to-face	02:00	66%	3 / 10	CE 2. CE 7. CE 8. CG 2 CG 3 CG 9 CG 11
16	Exam on Liquid crystals	Written test	Face-to-face	02:00	34%	3 / 10	CE 2. CE 7. CE 8. CG 2 CG 3 CG 9 CG 11

7.1.2. Global examination

Week	Description	Modality	Type	Duration	Weight	Minimum grade	Evaluated skills
17	Final exam	Written test	No Presential	02:00	100%	5 / 10	CE 2. CE 7. CE 8. CG 2 CG 3 CG 9 CG 11

7.1.3. Referred (re-sit) examination

No se ha definido la evaluación extraordinaria.

7.2. Assessment criteria

IF NECESSARY FOR SANITARY REASONS, THE TEACHING AND GRADING ACTIVITIES WILL BE PERFORMED ONLINE.

Students will be graded, by default, through progressive evaluation. Grading will follow the formula:

Mark= 0.66 x (Result of the exam on biomimetics, weeks 1-11)+ 0.34 x (Result of the exam on liquid crystals, weeks 13-16)

8. Teaching resources

8.1. Teaching resources for the subject

Name	Type	Notes
Biological Materials and Biomaterials	Bibliography	Free access for UPM students at www.ingebook.es
Initiation into statistical physics	Bibliography	Free access to UPM students at www.ingebook.com
Materiales Biológicos y Biomateriales	Bibliography	Free access to UPM students at www.ingebook.com
Liquid crystals	Bibliography	Liquid Crystals. I.C. Khoo (2007), Hoboken

Introduction to liquid crystals: Chemistry and Physics	Bibliography	Introduction to liquid crystals: Chemistry and Physics. P.J. Collings & M. Hird (2004). Taylor & Francis

9. Other information

9.1. Other information about the subject

This subject contributes to the following objectives for the Sustainable Development of UN, through the learning process and with the following results:l

OBJECTIVE 3: Guaranty a healthy life and promote the welfare for all persons and at all ages