ANX-PR/CL/001-01

LEARNING GUIDE

SUBJECT

43000608 - MecÁnica De Impacto

DEGREE PROGRAMME

04AN - Master Universitario En Ingenieria De Materiales

ACADEMIC YEAR & SEMESTER

2023/24 - Semester 2

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1. Description

1.1. Subject details

Name of the subject	43000608 - Mecánica de Impacto
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 *
Victor Rey De Pedraza Ruiz	04A.S1.061.0	v.rey@upm.es	Sin horario. Bajo petición
Rafael Sancho Cadenas	04A.S1.061.0	rafael.sancho@upm.es	Sin horario. Bajo peticion

Francisco Rafael Galvez Diaz-Rubio (Subject coordinator)	04A.S1.079.0	f.galvez@upm.es	Sin horario. Bajo peticion
David Angel Cendon Franco	04A.S1.070.0	david.cendon.franco@upm.es	Sin horario. Bajo peticion

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

3. Skills and learning outcomes *

3.1. Skills to be learned

CB06 - Poseer y comprender conocimientos que aporten una base u oportunidad de ser originales en el desarrollo y/o aplicación de ideas, a menudo en un contexto de investigación

CB07 - 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

CB08 - Que los estudiantes sean capaces de integrar conocimientos y enfrentarse a la complejidad de formular juicios a partir de una información que, siendo incompleta o limitada, incluya reflexiones sobre las responsabilidades sociales y éticas vinculadas a la aplicación de sus conocimientos y juicios

CB09 - Que los estudiantes sepan comunicar sus conclusiones y los conocimientos y razones últimas que las sustentan a públicos especializados y no especializados de un modo claro y sin ambigüedades

CB10 - Que los estudiantes posean las habilidades de aprendizaje que les permitan continuar estudiando de un modo que habrá de ser en gran medida autodirigido o autónomo.

CE2 - Uso de equipos y técnicas experimentales de caracterización de materiales (micro y macroestructura, comportamientos mecánico, eléctrico, y óptico) para identificar y analizar los diversos tipos de materiales / Use of equipment and experimental techniques for the characterization of materials (micro and macrostructure, mechanical, electrical, and optical behavior) to identify and analyze the various types of materials.

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

CE7 - Manejo de herramientas de simulación numérica para diseño y análisis de materiales, desde la escala microscópica a la macroscópica / Management of numerical simulation tools for design and analysis of materials, from the microscopic to the macroscopic scale

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 .

CG3 - Trabajo en equipo: Los alumnos desarrollan la capacidad para trabajar en equipo, integrarse y colaborar de forma activa en la consecución de objetivos comunes / Teamwork: Students develop the ability to work as a team, integrate and actively collaborate in achieving common goals.

CG8 - Resolución de problemas: Los estudiantes son capaces de reconocer, describir, organizar y analizar los elementos constitutivos de un problema para idear estrategias que permitan obtener, de forma razonada, una solución contrastada y acorde a ciertos criterios preestablecidos / Problem solving: Students are able to recognize, describe, organize and analyze the constitutive elements of a problem to devise strategies that allow obtaining, in a reasoned way, a contrasting solution and according to certain pre-established criteria.

CG9 - Que los estudiantes sepan comunicar sus conclusiones y los conocimientos y razones últimas que las sustentan a públicos especializados y no especializados de un modo claro y sin ambigüedades

3.2. Learning outcomes

RA4 - Que los estudiantes sepan comunicar sus conclusiones (y los conocimientos y razones últimas que las sustentan) a públicos especializados y no especializados de un modo claro y sin ambigüedades

RA1 - Saber comunicar conocimientos, procedimientos, resultados o técnicas relacionadas con el comportamiento y el uso de materiales

RA8 - RA32 - Conocer, comprender y saber aplicar los fundamentos científicos del comportamiento de los materiales

* 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.

4. Brief description of the subject and syllabus

4.1. Brief description of the subject

Introduction Dynamic behaviour of materials
Numerical Methods and Numerical Simulation

Elastic Waves

Plastic Waves

Experimental Methods

Compression tests. (LAB EXPERIMENTS)

Shock waves

Blast and explosion

Introduction to ballistics

Analytical models for ballistics

Impact testing. (LAB EXPERIMENT)

4.2. Syllabus

1. Introduction Dynamic behaviour of materials
2. Numerical Methods and Numerical Simulation
3. Elastic Waves
4. Plastic Waves
5. Experimental Methods
6. Compression tests. (LAB EXPERIMENTS)
7. Shock waves
8. Blast and explosion
9. Introduction to ballistics
10. Analytical models for ballistics
11. Impact testing. (LAB EXPERIMENT)

5. Schedule

5.1. Subject schedule*

Week	Classroom activities	Laboratory activities	Distant / On-line	Assessment activities
1	**Introduction** Duration: 01:00 Lecture **Dynamic behaviour of materials** Duration: 01:00 Lecture			**Class attendance** Other assessment Continuous assessment Presential Duration: 00:00
2	**Numerical Methods** Duration: 01:00 Lecture	**Numerical Simulation** Duration: 01:00 Laboratory assignments		**Class attendance** Other assessment Continuous assessment Presential Duration: 00:00
3	**Elastic waves in solids** Duration: 01:00 Lecture	**Numerical Simulation** Duration: 01:00 Laboratory assignments		**Class attendance** Other assessment Continuous assessment Presential Duration: 00:00
4	**Plastic waves in solids** Duration: 01:00 Lecture **Exercises of waves in solids** Duration: 01:00 Problem-solving class			**Class attendance** Other assessment Continuous assessment Presential Duration: 00:00
5	**Experimental Methods** Duration: 01:00 Lecture	**Numerical Simulation** Duration: 01:00 Laboratory assignments		**Class attendance** Other assessment Continuous assessment Presential Duration: 00:00 **Evaluation Test** Written test Continuous assessment Presential Duration: 00:20
6		**Numerical Simulation Groups B** Duration: 02:00 Laboratory assignments **Experimental compression tests at different strain rates. Groups A** Duration: 02:00 Laboratory assignments		**Class attendance** Other assessment Continuous assessment Presential Duration: 00:00 **Report Numerical Simulation 2** Individual work Continuous assessment Presential Duration: 00:00

7		**Numerical Simulation Groups A** Duration: 02:00 Laboratory assignments **Experimental compression tests at different strain rates. Groups B** Duration: 02:00 Laboratory assignments		**Class attendance** Other assessment Continuous assessment Presential Duration: 00:00
8	**Shock Waves in solids** Duration: 01:00 Lecture	**Numerical Simulation** Duration: 01:00 Laboratory assignments		**Class attendance** Other assessment Continuous assessment Presential Duration: 00:00
9	**Blast and explosion** Duration: 01:00 Lecture	**Numerical Simulation** Duration: 01:00 Laboratory assignments		**Evaluation Test** Written test Continuous assessment Presential Duration: 00:30 **Class attendance** Other assessment Continuous assessment Presential Duration: 00:00 **Report Experimental tests 1 and numerical Simulation 3** Individual work Continuous assessment Presential Duration: 00:00
10	**Introduction to Ballistics** Duration: 01:00 Lecture	**Numerical Simulation** Duration: 01:00 Laboratory assignments		**Class attendance** Other assessment Continuous assessment Presential Duration: 00:00
11	**Analytical Models in Ballistics** Duration: 01:00 Lecture **Exercises of Impact Mechanics** Duration: 01:00 Problem-solving class			**Class attendance** Other assessment Continuous assessment Presential Duration: 00:00
12		**Experimental: Gas gun Impacts** Duration: 02:00 Laboratory assignments		**Evaluation Test** Written test Continuous assessment Presential Duration: 00:30 **Class attendance** Other assessment Continuous assessment Presential Duration: 00:00

13	**Impact on composite materials** Duration: 02:00 Lecture			**Class attendance** Other assessment Continuous assessment Presential Duration: 00:00
14	**Impact on composite materials** Duration: 02:00 Lecture			**Class attendance** Other assessment Continuous assessment Presential Duration: 00:00 **Report Experimental tests 2 and numerical Simulation 4** Individual work Continuous assessment Presential Duration: 00:00
15	**Presentation of experimental and numertical work** Duration: 02:00 Additional activities			**Evaluation Test** Written test Continuous assessment Presential Duration: 00:30 **Term project. Students presentations** Group work Continuous assessment Presential Duration: 01:40 **Class attendance** Other assessment Continuous assessment Presential Duration: 00:00
16	**Presentation of group work** Duration: 02:00 Additional activities			
17				**Final Exam** Written 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.

6. Activities and assessment criteria

6.1. Assessment activities

6.1.1. Assessment

Week	Description	Modality	Type	Duration	Weight	Minimum grade	Evaluated skills
1	Class attendance	Other assessment	Face-to-face	00:00	2%	/ 10	
2	Class attendance	Other assessment	Face-to-face	00:00	2%	/ 10	
3	Class attendance	Other assessment	Face-to-face	00:00	2%	/ 10	
4	Class attendance	Other assessment	Face-to-face	00:00	2%	/ 10	
5	Class attendance	Other assessment	Face-to-face	00:00	2%	/ 10	
5	Evaluation Test	Written test	Face-to-face	00:20	8%	/ 10	CB07 CB08 CB09 CB10 CG9 CG1 CG8 CE4
6	Class attendance	Other assessment	Face-to-face	00:00	2%	/ 10	
6	Report Numerical Simulation 2	Individual work	Face-to-face	00:00	8%	/ 10	CB06 CB07 CB08 CB09 CB10 CG9 CG1 CG3 CG8 CE4 CE7
7	Class attendance	Other assessment	Face-to-face	00:00	2%	/ 10	

8	Class attendance	Other assessment	Face-to-face	00:00	2%	/ 10	
9	Evaluation Test	Written test	Face-to-face	00:30	8%	/ 10	
9	Class attendance	Other assessment	Face-to-face	00:00	2%	/ 10	
9	Report Experimental tests 1 and numerical Simulation 3	Individual work	Face-to-face	00:00	8%	/ 10	CE2 CE7
10	Class attendance	Other assessment	Face-to-face	00:00	2%	/ 10	
11	Class attendance	Other assessment	Face-to-face	00:00	2%	/ 10	
12	Evaluation Test	Written test	Face-to-face	00:30	8%	/ 10	CE2 CE7
12	Class attendance	Other assessment	Face-to-face	00:00	2%	/ 10	
13	Class attendance	Other assessment	Face-to-face	00:00	2%	/ 10	
14	Class attendance	Other assessment	Face-to-face	00:00	2%	/ 10	
14	Report Experimental tests 2 and numerical Simulation 4	Individual work	Face-to-face	00:00	10%	/ 10	CE2 CE7
15	Evaluation Test	Written test	Face-to-face	00:30	8%	/ 10	CB06 CB07 CB08 CB09 CB10 CG9 CG1 CG8 CE4
15	Term project. Students presentations	Group work	Face-to-face	01:40	12%	/ 10	CB06 CB07 CB08 CB09 CB10 CG9 CG1 CG3 CG8 CE2 CE4 CE7
15	Class attendance	Other assessment	Face-to-face	00:00	2%	/ 10	

6.1.2. Global examination

Week	Description	Modality	Type	Duration	Weight	Minimum grade	Evaluated skills
17	Final Exam	Written test	Face-to-face	02:00	100%	5 / 10	CB08 CB09 CG9 CG1 CG3 CG8 CE2 CE4 CE7

6.1.3. Referred (re-sit) examination

Description	Modality	Type	Duration	Weight	Minimum grade	Evaluated skills
Final Exam	Written test	Face-to-face	02:00	100%	5 / 10	CB06 CB07 CB08 CB09 CB10 CG9 CG1 CG3 CG8 CE2 CE4 CE7

6.2. Assessment criteria

Aessment criteria
A. CONTINUUM ASESSMENT

The final mark consists of continuous assessment and a term project. The final mark is obtained through the following items: class attendance and exercises (CA), several tests covering the lectures (TS), the simulation and lab exercises (SM) and term project (TP):

o CA Class attendance and Proposed Exercises. 25%

o TS Average of the marks obtained in the tests. 25%

o SM Average of simulation / lab exercises. 25%

o TP Term project (final work including presentation). 25%

Pass mark: 0.25*CA+0.25*TS+0.25*SM+0.25*TP > 5

B. FINAL EXAM

The exam weights 100%.

7. Teaching resources

7.1. Teaching resources for the subject

Name	Type	Notes
Text book 1	Bibliography	Meyers, M.A., Dynamic Behavior of Materials. John Willey & Sons. 1994
Text Book 2	Bibliography	Zukas, N. Impact Dynamics. John Willey & Sons. 1982.
Text Book 3	Bibliography	Zukas, N. High velocity Impact Dynamics. John Willey & Sons. 1990.
Text Book 4	Bibliography	Johnson, W. Impact strength of materials. Edward Arnold Ed. 1972.
Laptop	Equipment	The student should bring his own laptop for the numerical simulations.
Experimental device 1	Equipment	Universal compression machine
Experimental device 2	Equipment	Compression Hopkinson Bar
Experimental Device 3	Equipment	Impact Gas Gun
License Server	Others	License server of LsDyna for numerical simulations

8. Other information

8.1. Other information about the subject

Esta asignatura contribuye a los siguientes Objetivos de Desarrollo sostenible de la ONU, a través de sus procesos de aprendizaje y con los resultados obtenidos:
Los objetivos 8, 9, 10 y 11 son citados como muy alineados con nuestra actividad

8. Fomentar el crecimiento económico sostenido, inclusivo y sostenible, el empleo pleno y productivo, y el trabajo decente para todos.

9. Desarrollar infraestructuras resilientes, promover la industrialización inclusiva y sostenible, y fomentar la innovación.

10. Reducir las desigualdades entre países y dentro de ellos.

11. Conseguir que las ciudades y los asentamientos humanos sean inclusivos, seguros, resilientes y sostenibles.