UNIVERSIDAD DE CASTILLA - LA MANCHA

GUÍA DOCENTE

1. General information

Course: STRENGTH OF MATERIALS
Code: 56713
Type: CORE COURSE
ECTS credits: 6
Degree: 403 - UNDERGRADUATE DEGREE PROGRAMME IN AEROSPACE ENGINEERING
Academic year: 2023-24
Center: 303 - E.DE INGENIERÍA INDUSTRIAL Y AEROESPOACIAL DE TOLEDO
Group(s): 40
Year: 2
Duration: First semester
Main language: Spanish
Second language: English
Use of additional languages:
English Friendly: Y
Web site: https://campusvirtual.uclm.es/
Bilingual: N

Lecturer: **SERGIO HORTA MUÑOZ** - Group(s): **40**

Building/Office	Department	Phone number	Email	Office hours
Sabatini / Despacho 1.05	MECÁNICA ADA. E ING. PROYECTOS	926052830	Sergio.Horta@uclm.es	In person: timetable will be published at the beginning of the semester. Online: permanently on the Virtual Campus (Moodle Platform), Teams and at the email address Sergio.Horta@uclm.es. The tutorial schedule will be published at the address: https://www.uclm.es/toledo/eiia/informacion_academica/

Lecturer: **MARIA DEL CARMEN SERNA MORENO** - Group(s): **40**

Building/Office	Department	Phone number	Email	Office hours
Sabatini / Despacho 1.05	MECÁNICA ADA. E ING. PROYECTOS	926052569	mariacarmen.serna@uclm.es	In person: timetable will be published at the beginning of the semester. Online: permanently on the Virtual Campus (Moodle Platform), Teams and at the email address mariacarmen.serna@uclm.es. The tutorial schedule will be published at the address: https://www.uclm.es/toledo/eiia/informacion_academica/

2. Pre-Requisites

It is recommended that the student has acquired the knowledge imparted in the courses of Calculus I, Calculus II and Physics I, as well as that they have taken or are taking the subject Materials Science: basic concepts of differential calculus, integration, statics (equilibrium, inertia, etc) and mechanical properties of the material (modulus of elasticity and shear modulus, Poisson's ratio, yielding strength, etc).

3. Justification in the curriculum, relation to other subjects and to the profession

This subject provides the student with the basic skills necessary to carry out the professional activity of Aeronautical Engineer, particularly those related to the fundamental concepts of structural calculation. The knowledge acquired in this subject serves as the basis for acquiring the skills developed in the following compulsory subjects of the Degree in Aerospace Engineering: Mechanics of the Deformable Solid, Aeronautical Structures, Materials Engineering and Technology, Aerospace Structural Materials, Machines and Mechanisms, Vibrations and Aeroelasticity .

4. Degree competences achieved in this course

Course competences

Code	Description
CA01	Ability to carry out bibliographic searches, use databases and other sources of information for its application in tasks related to Technical Aeronautical Engineering.
CA02	Ability to efficiently design experimentation procedures, interpret the data obtained and specify valid conclusions in the field of Aeronautical Technical Engineering.
CA03	Ability to autonomously select and carry out the appropriate experimental procedure, operating the equipment correctly, in the analysis of phenomena within the scope of Engineering.
CA04	Ability to select advanced tools and techniques and their application in the field of Aeronautical Technical Engineering.
CA05	Knowledge of the methods, techniques and tools as well as their limitations in the application for the resolution of problems typical of Aeronautical Technical Engineering.
CA06	Ability to identify and assess the effects of any solution in the field of Aeronautical Technical Engineering within a broad and global context and the ability to interrelate the solution to an engineering problem with other variables beyond the technological field, which must be considered.
CB02	Apply their knowledge to their job or vocation in a professional manner and show that they have the competences to construct and justify arguments and solve problems within their subject area.
CB04	Transmit information, ideas, problems and solutions for both specialist and non-specialist audiences.
CB05	Have developed the necessary learning abilities to carry on studying autonomously
CE07	Knowledge of the behavior of the structural stress in service conditions and limit situations.
CE11	Knowledge of the technological benefits, the optimization techniques of the materials and the modification of their properties by means of treatments.
CE19	Applied knowledge of: materials science and technology; mechanics and thermodynamics; fluid mechanics; aerodynamics and mechanics of flight; air traffic and navigation systems; aerospace technology; structure theory; air Transport; economy and production; Projects; environmental impact.
	Knowledge applied to Engineering of: Technological performance, optimization techniques for materials used in the aerospace sector

CE23	and treatment processes to modify their mechanical properties.
CE26	Applied knowledge of: aerodynamics; flight mechanics, air defense engineering (ballistics, missiles and air systems), space propulsion, materials science and technology, structural theory.
CG01	Capacity for the design, development and management in the field of aeronautical engineering that have as their object, in accordance with the knowledge acquired as established in section 5 of order CIN/308/2009, aerospace vehicles, propulsion systems aerospace, aerospace materials, airport infrastructures, air navigation infrastructures and any space, traffic and air transport management system.
CT03	Correct use of oral and written communication.
CT05	Knowledge of the principles of management skills and teamwork.

5. Objectives or Learning Outcomes

Course learning outcomes

Description

Knowledge of the basics of structural calculations through the matrix method (Resistance of Materials).

Acquisition of the fundamental concepts of the theory of structures: displacements, strain and stress, as well as to calculate and dimension simple one-dimensional structures with manual methods.

6. Units / Contents

Unit 1: Introduction to Strength of Materials

- **Unit 1.1** Objectives. Basic principles.
- **Unit 1.2** Idealization of structural members. Boundary conditions. Load types
- **Unit 1.3** Static equilibrium. Reactions and section forces.
- **Unit 1.4** Isostatic and hyperestatic structures
- **Unit 1.5** Exercises

Unit 2: Isostatic systems

- **Unit 2.1** Beams. Calculation of reactions and internal forces. Deformed shape
- **Unit 2.2** Pin-jointed frames. Method of joint. Method of section.
- **Unit 2.3** Superposition principle.
- **Unit 2.4** Exercises

Unit 3: Methods for calculating rotations and displacements

- **Unit 3.1** Introduction
- **Unit 3.2** Euler-Navier-Bernoulli model. Field equation
- **Unit 3.3** Mohr's Theorems
- **Unit 3.4** Principle of Virtual Works
- **Unit 3.5** Exercises

Unit 4: Hyperstatic systems

- **Unit 4.1** Introduction
- **Unit 4.2** External and internal hyperestaticity.
- **Unit 4.3** Compatbility Method
- **Unit 4.4** Exercises

Unit 5: Geometrical properties of the cross-sections

- **Unit 5.1** Introduction
- **Unit 5.2** Centroid
- **Unit 5.3** Moment of area
- **Unit 5.4** Second moments of area
- **Unit 5.5** Steiner's theorem
- **Unit 5.6** Inertia principal axes
- **Unit 5.7** Exercises

Unit 6: Normal stresses statically equivalent to axial force and bending moment

- **Unit 6.1** Navier's law
- **Unit 6.2** Calculation and representation of normal stresses. Neutral fibre
- **Unit 6.3** Section modulus
- **Unit 6.4** Stress combinations: axial force only, pure bending, simple bending, compound bending, deviated compound bending
- **Unit 6.5** Exercises

Unit 7: Shear stresses statically equivalent to shear section forces

- **Unit 7.1** Calculation and representation of shear stresses. Static moments
- **Unit 7.2** Thick-walled sections
- **Unit 7.3** Thin-walled sections. Center of shear forces
- **Unit 7.4** Exercises

Unit 8: Introduction to elastic stability

- **Unit 8.1** Concept of buckling
- **Unit 8.2** Euler's critical load. Other boundary conditions. Buckling length.
- **Unit 8.3** Radius of gyration and slenderness ratio. Buckling plane
- **Unit 8.4** Exercises

Unit 9: Introduction to uniform torsion

- **Unit 9.1** Statement of the problem
- **Unit 9.2** Calculation of reactions and twisting moments diagrams
- **Unit 9.3** Thick-walled sections. Circular and annular section. Polar moment of inertia. Rectangular section. Torsional constant and warp modulus
- **Unit 9.4** Unicellular open and closed thin-walled sections
- **Unit 9.5** Exercises

Unit 10: Introduction to stiffness matrix methods

- **Unit 10.1** Stiffness matrix method

7. Activities, Units/Modules and Methodology

Training Activity	Methodology	Related Competences (only degrees before RD 822/2021)	ECTS	Hours	As	Com	Description
Class Attendance (theory) [ON-SITE]	Lectures	CA01 CA04 CA05 CA06 CB02 CB05 CE07 CE11 CE19 CE23 CE26 CG01	0.9	22.5	N	-	Development of theoretical contents in classroom, using the participatory lecture method.
Group tutoring sessions [ON-SITE]	Problem solving and exercises	CA01 CA02 CA03 CA04 CA05 CA06 CB02 CB04 CB05 CE07 CE11 CE19 CE23 CE26 CG01 CT03 CT05	0.16	4	N	-	Group tutorials, direct teacher-student interaction
Problem solving and/or case studies [ON-SITE]	Problem solving and exercises	CA01 CA04 CA05 CA06 CB02 CB04 CB05 CE07 CE11 CE19 CE23 CE26 CG01 CT03 CT05	0.9	22.5	N	-	Resolution of exercises and problems in the classroom in a participatory way.
Laboratory practice or sessions [ON-SITE]	Practical or hands-on activities	CA01 CA02 CA03 CA04 CA05 CA06 CB02 CB04 CB05 CE07 CE11 CE19 CE23 CE26 CG01 CT03 CT05	0.26	6.5	N	-	Laboratory practices
Computer room practice [ON-SITE]	Practical or hands-on activities	CA01 CA02 CA03 CA04 CA05 CA06 CB02 CB04 CB05 CE07 CE11 CE19 CE23 CE26 CG01 CT03 CT05	0.06	1.5	N	-	Practices in the computer room, with the use of specific software for calculating structures
Final test [ON-SITE]	Assessment tests	CA01 CA02 CA03 CA04 CA05 CA06 CB02 CB04 CB05 CE07 CE11 CE19 CE23 CE26 CG01 CT03	0.08	2	Y	Y	Final test.
Study and Exam Preparation [OFF-SITE]	Self-study	CA01 CA02 CA03 CA04 CA05 CA06 CB02 CB04 CB05 CE07 CE11 CE19 CE23 CE26 CG01 CT03 CT05	3.1	77.5	N	-	Personal study of theory and problems.
Progress test [ON-SITE]	Assessment tests	CA01 CA02 CA03 CA04 CA05 CA06 CB02 CB04 CB05 CE07 CE11 CE19 CE23 CE26 CG01 CT03	0.04	1	Y	N	Follow-up test in which the student solves practical cases and/or questions on the subject.
Writing of reports or projects [OFF-SITE]	Group Work	CA01 CA02 CA03 CA04 CA05 CA06 CB02 CB04 CB05 CE07 CE11 CE19 CE23 CE26 CG01 CT03 CT05	0.5	12.5	Y	N	Resolution and delivery of a theoretical-practical group work to be done at home.
		Total:	**6**	**150**			
		Total credits of in-class work: 2.4					**Total class time hours: 60**
		Total credits of out of class work: 3.6					**Total hours of out of class work: 90**

As: Assessable training activity
Com: Training activity of compulsory overcoming (It will be essential to overcome both continuous and non-continuous assessment).

8. Evaluation criteria and Grading System

Evaluation System	Continuous assessment	Non-continuous evaluation*	Description
Progress Tests	15.00%	15.00%	C: Test to monitor the student's learning. Recoverable. NC: test carried out on the date of the ordinary/extraordinary call.
Projects	15.00%	15.00%	C: Theoretical-practical exercises to be solved in groups. Recoverable. NC: Delivery of the theoretical-practical exercises on the day of the final exam.
Final test	70.00%	70.00%	C: final test that will consist of theoretical questions and/or problems. Recoverable. NC: final test that will consist of theoretical questions and/or problems. The minimum grade for this part to be compensable will be 4 points (out of 10)
Total:	**100.00%**	**100.00%**	

According to art. 4 of the UCLM Student Evaluation Regulations, it must be provided to students who cannot regularly attend face-to-face training activities the passing of the subject, having the right (art. 12.2) to be globally graded, in 2 annual calls per subject , an ordinary and an extraordinary one (evaluating 100% of the competences).

Evaluation criteria for the final exam:

Continuous assessment:

Final Exam (E): Test that will consist of theoretical questions and/or problems. To pass the subject it will be necessary to obtain a minimum grade of 4 in the final test (70%)

Projects(T): Theoretical-practical exercises to be solved individually and/or in a group (15%)

Progress Test (PP): Test that will consist of theoretical questions and/or problems (15%).

It will be considered that the student has passed the subject if, being E >= 4 and calculating the final mark as Final Mark = E*0.7+ T*0.15 + PP*0.15, the Final Mark is greater than or equal to 5. In case of that E < 4, the final grade cannot be higher than 4.

Grades obtained in previous courses will not be retained.

Non-continuous evaluation:

Final Exam (E): Test that will consist of theoretical questions and/or problems. To pass the subject it will be necessary to obtain a minimum grade of 4 in the final test (70%),

Progress Test (PP): test that will evaluate the contents evaluated in the Progress Test of the continuous assessment (15%).

To assess the competences evaluated with the Projects (15%), either the student will be asked to submit the work or an additional test will be carried out on the same day of the Final Exam with theoretical-practical questions and/or exercises to be solved in the classroom. of computers.

The Final Mark of the subject will be obtained as NF=0.7*E+0.15*PP+0.15*T, being necessary a Final Mark greater than or equal to 5 to pass the subject. In the event that E < 4, the final grade may not be higher than 4.

Specifications for the resit/retake exam:

An exam will be carried out that will consist of theoretical questions and/or problems that will include the competencies evaluated in the Final Exam (70%) and in the Progress Test (15%). To pass the subject it will be necessary to obtain a minimum grade of 4 in the Final Exam.

To assess the competencies evaluated with the Projects (15%): The student who requests it will keep the grade obtained in the Work of the ordinary call. The student who chooses not to keep the grade obtained in the work in the ordinary call, will either be asked to submit the work or an additional test will be carried out on the same day of the Final Exam with theoretical-practical questions and/or exercises to be solved in computer room.

The Final Mark of the subject will be obtained as NF=0.7*E+0.15*PP+0.15*T, being necessary a Final Mark greater than or equal to 5 to pass the subject. In the event that E < 4, the final grade may not be higher than 4.

Specifications for the second resit / retake exam:

An exam will be carried out that will consist of theoretical questions and/or problems that will include the competencies evaluated in the Final Exam (70%) and in the Progress Test (15%). To pass the subject it will be necessary to obtain a minimum grade of 4 in the Final Exam.

To assess the competencies evaluated with the Projects (15%): the delivery of a work will be requested or an additional test will be carried out on the same day of the Final Exam with theoretical-practical questions and/or exercises to be solved in a computer room.

The Final Mark of the subject will be obtained as NF=0.7*E+0.15*PP+0.15*T, being necessary a Final Mark greater than or equal to 5 to pass the subject. In the event that E < 4, the final grade may not be higher than 4.

9. Assignments, course calendar and important dates

Not related to the syllabus/contents	
Hours	**hours**
Group tutoring sessions [PRESENCIAL][Problem solving and exercises]	4
Laboratory practice or sessions [PRESENCIAL][Practical or hands-on activities]	6.5
Computer room practice [PRESENCIAL][Practical or hands-on activities]	1.5
Final test [PRESENCIAL][Assessment tests]	2
Progress test [PRESENCIAL][Assessment tests]	12.5
Progress test [PRESENCIAL][Assessment tests]	1
Writing of reports or projects [AUTÓNOMA][Group Work]	12.5
Unit 1 (de 10): Introduction to Strength of Materials	
Activities	**Hours**
Class Attendance (theory) [PRESENCIAL][Lectures]	1.5
Unit 2 (de 10): Isostatic systems	
Activities	**Hours**
Class Attendance (theory) [PRESENCIAL][Lectures]	2.5
Problem solving and/or case studies [PRESENCIAL][Problem solving and exercises]	3
Study and Exam Preparation [AUTÓNOMA][Self-study]	5
Unit 3 (de 10): Methods for calculating rotations and displacements	
Activities	**Hours**
Class Attendance (theory) [PRESENCIAL][Lectures]	3.5
Problem solving and/or case studies [PRESENCIAL][Problem solving and exercises]	3.5
Study and Exam Preparation [AUTÓNOMA][Self-study]	3.5
Unit 4 (de 10): Hyperstatic systems	
Activities	**Hours**
Class Attendance (theory) [PRESENCIAL][Lectures]	2
Problem solving and/or case studies [PRESENCIAL][Problem solving and exercises]	3
Study and Exam Preparation [AUTÓNOMA][Self-study]	9
Unit 5 (de 10): Geometrical properties of the cross-sections	
Activities	**Hours**
Class Attendance (theory) [PRESENCIAL][Lectures]	2

Problem solving and/or case studies [PRESENCIAL][Problem solving and exercises]	2
Study and Exam Preparation [AUTÓNOMA][Self-study]	10
Unit 6 (de 10): Normal stresses statically equivalent to axial force and bending moment	
Activities	**Hours**
Class Attendance (theory) [PRESENCIAL][Lectures]	2.5
Problem solving and/or case studies [PRESENCIAL][Problem solving and exercises]	2.5
Study and Exam Preparation [AUTÓNOMA][Self-study]	10
Unit 7 (de 10): Shear stresses statically equivalent to shear section forces	
Activities	**Hours**
Class Attendance (theory) [PRESENCIAL][Lectures]	3
Problem solving and/or case studies [PRESENCIAL][Problem solving and exercises]	3
Study and Exam Preparation [AUTÓNOMA][Self-study]	10
Unit 8 (de 10): Introduction to elastic stability	
Activities	**Hours**
Class Attendance (theory) [PRESENCIAL][Lectures]	1
Problem solving and/or case studies [PRESENCIAL][Problem solving and exercises]	1
Study and Exam Preparation [AUTÓNOMA][Self-study]	10
Unit 9 (de 10): Introduction to uniform torsion	
Activities	**Hours**
Class Attendance (theory) [PRESENCIAL][Lectures]	2
Problem solving and/or case studies [PRESENCIAL][Problem solving and exercises]	2
Study and Exam Preparation [AUTÓNOMA][Self-study]	10
Unit 10 (de 10): Introduction to stiffness matrix methods	
Activities	**Hours**
Class Attendance (theory) [PRESENCIAL][Lectures]	2.5
Problem solving and/or case studies [PRESENCIAL][Problem solving and exercises]	2.5
Study and Exam Preparation [AUTÓNOMA][Self-study]	10
Global activity	
Activities	**hours**
Group tutoring sessions [PRESENCIAL][Problem solving and exercises]	4
Problem solving and/or case studies [PRESENCIAL][Problem solving and exercises]	22.5
Laboratory practice or sessions [PRESENCIAL][Practical or hands-on activities]	6.5
Computer room practice [PRESENCIAL][Practical or hands-on activities]	1.5
Final test [PRESENCIAL][Assessment tests]	2
Class Attendance (theory) [PRESENCIAL][Lectures]	22.5
Study and Exam Preparation [AUTÓNOMA][Self-study]	77.5
Progress test [PRESENCIAL][Assessment tests]	1
Writing of reports or projects [AUTÓNOMA][Group Work]	12.5
Total horas:	150

10. Bibliography and Sources

Author(s)	Title/Link	Publishing house	Citv	ISBN	Year	Description
Den Hartog J.P.	STRENGTH OF MATERIALS	Dover			1961	
Garrido García, José A.	Resistencia de materiales	Secretariado de Publicaciones e Intercambio Cie		84-7762-951-X	1999	
MacGuire, William	Matrix structural analysis	John Wiley & Sons		0-471-12918-6	2000	
Ortiz Berrocal, Luis	Resistencia de materiales	McGraw-Hill		84-7615-512-3	1999	
Timoshenko S.P., Gere J.M.	Resistencia de Materiales	Thomson			2002	
Timoshenko, Stephen (1878-1972)	Resistencia de materiales	Espasa-Calpe		84-239-6315-2 (t.1)	1980	
Vázquez Fernández, Manuel	Resistencia de materiales	Noela		84-88012-05-5	1999	