# Professional Software for Solid Mechanics

**ECTS**: 6 ECTS

**COORDINATOR**: Peregrina Quintela Estévez (peregrina.quintela@usc.es)

**UNIVERSITY WHERE THE COORDINATOR IS:** USC

**HAVE YOU GIVEN PERMISSION TO RECORD YOUR CLASSES?** Yes

**LECTURER 1:** José Ramón Fernández García (jose.fernandez@uvigo.es)

**UNIVERSITY WHERE THE LECTURER 1 IS:** UVigo

**HAVE YOU GIVEN PERMISSION TO RECORD YOUR CLASSES?** No

**SUBJECT CONTENTS**

Part 1. Linear stationary and dynamic elasticity.

1.a. 3D models of elasticity.

1.b. 2D models of plane strain and plane stress.

1.c. 2D models of plates and shells.

1.d. 2D models for axially symmetric behaviour

1.e. 1D models of beams.

1.f. Multidimensional models.

1.g. Calculation of eigenfrequencies and eigenmodes of vibration.

1.h. Linear thermoelasticity.

1.i. Anisotropy.

Part 2. Non-linear elasticity

2.a. Non-linear materials: elastoplastic materials, von Mises' and Tresca's creep laws. Hill's criterion.

2.b. Isotropic and kinematic hardening.

2.c. Contact problems. Contact with rigid solid or deformable solid.

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**METHODOLOGY**

The sessions will be telematic from the classrooms assigned for this purpose by the USC (Part 1) and by UVigo (Part 2). The class sessions will be taught through the telematic teaching platforms available at the USC and UVigo (see Observations).

They will consist of three different parts:

A. Explanation of physical problems: mathematical modelling and design of academic tests. The aim is to develop the competences CG1, CG2, CG4, CG5, CE1 and CE2.

B. Planning of the tasks that allow solving them with the software packages: Patran-Nastran and Mentat-Marc. The competences CG1, CG2, CG4, CG5, CE4, CS1 and CS2 are handled.

C. Computer resolution and analysis of the results. In this section the competences CG1, CG2, CG3, CG4, CG5, CE5, CS1 and CS2 are worked on.

The classes will be supported by a digital presentation that will be made available to the student through a virtual course of the subject. Throughout the course an individual work corresponding to Part 1 will be proposed and will be taken into account in the assessment of the personal work.

The course will have video notes of at least sections A and B of Part 1 of the subject, which will facilitate their study.

The USC Virtual Campus will be used and a team will be created in Teams to facilitate virtual tutorials (Part 1) and the UVigo Remote Campus.

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**LANGUAGE USED IN CLASS:** Spanish.

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**IS IT COMPULSORY TO ATTEND CLASS?** Attendance is not compulsory, although, it is recommended that as far as possible students attend in person at USC (Part 1) or UVigo (Part 2).

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**BIBLIOGRAPHY**

BASIC BIBLIOGRAPHY

• Barral, P. and Quintela, P. Modelos Matemáticos na Mecánica de Sólidos. Curso Virtual de la Universidad de Santiago de Compostela. Curso 2022-23.

• Bower, A.F. Applied Mechanics of Solids. CRC Press. 2010.

• García Barachina, L. Introducción a Patran / Nastran en el cálculo de estructuras. Editorial Paraninfo. 2014.

COMPLEMENTARY BIBLIOGRAPHY

• Bermúdez de Castro, A. Continuum Thermomechanics. Progress in Mathematical Physics. Edit. Birkhäuser. 2005.

• Gurtin, M.E. An Introduction to Continuum Mechanics. Academic Press. New York, 1981.

• Henry, J.P. y Parsy, F. Cours d'Élasticité. Dunod Université. 1982.

• Kikuchi, N.,Oden, J.T. (1988) Contact problems in elasticity. SIAM.

• Lemaitre J. A A course on damage mechanics. Springer-Verlag, 1996.

• Lemaitre, J., Chaboche, J.L. (1994) Mechanics of solids materials. Cambridge University Press.

• Sokolnikoff, I.S. Mathematical theory of elasticity. Krieger Publishing Company. 1956.• Timoshenko, S., Goodier,J.N. (1975) Teoría de la elasticidad. URMO.

• Tutorials and use cases of APEX, Patran, Nastran, Mentat and Marc. https://www.mscsoftware.com/

• Vinson, J.R. The Behavior of Thin Walled Structures, Beams, Plates and Shells. Kluwer academic publishers. 1989.

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**SKILLS**

General skills :

CG1 Have knowledge that provide a basis or opportunity for originality in developing and / or applying ideas, often within a research context, knowing how to translate industrial needs in terms of R&D in the field of mathematics Industrial.

CG2 Be able to apply the acquired knowledge and abilities to solve problems in new or unfamiliar environments within broader contexts, including the ability to integrate multidisciplinary R & D in the business environment.

CG3 Being able to integrate knowledge to state opinions using information that even incomplete or limited, include reflecting on social and ethical responsibilities linked to the application of their knowledge.

CG4 To have the ability to communicate the findings to specialist and non-specialist audiences in a clear and unambiguous way.

CG5 To have the appropriate learning skills to enable them to continue studying in a way that will be largely self-directed or autonomous, and also to be able to successfully undertake doctoral studies.

Specific skills :

CE1: To acquire a basic knowledge in an area of Engineering / Applied Science, as a starting point for an adequate mathematical modelling, using well-established contexts or in new or unfamiliar environments within broader and multidisciplinary contexts.

CE2: Model specific ingredients and make appropriate simplifications in the model to facilitate their numerical treatment, maintaining the degree of accuracy, according to previous requirements.

CE4: Being able to select a set of numerical techniques, languages, and tools, appropriate to solve a mathematical model.

CE5: Being able to validate and interpret the results, comparing them with visualizations, experimental measurements and functional requirements of the physical engineering system.

Numerical Simulation specialisation skills:

CS1: To know, be able to select or use how to handle most suitable professional software tools (both commercial and free) for the simulation of processes in the industrial and business sector.

CS2: To adapt, modify and implement software tools for numerical simulation.

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**WILL YOU BE USING A VIRTUAL PLATFORM?**

The USC Virtual Campus will be used, and a team will be created in Teams to facilitate virtual tutorials (Part 1). The UVigo Remote Campus will be used for Part 2.

**WILL YOU BE USING ANY SPECIFIC SOFTWARE?** Yes, APEX, PATRAN-NASTRAN, MENTAT-MARC.

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**CRITERIA FOR THE 1ST ASSESSMENT OPPORTUNITY**

In the supervision by the teacher of the class work, the students will show their handling of the competences CE1, CE2, CE4, CE5, CS1 and CS2.

A computer-based test will be given to all students, based on the exercises proposed throughout the course. This test will assess the competences CE1, CE2, CE4, CE5 and CS1.

Students will have to carry out a practical work corresponding to Part 1 of the subject. The final grade for Part 1 will be calculated considering 40% of the practical work grade plus 60% of the exam grade.

The subject grade for Part 2 will be that of the final computer-based test at both the first and second opportunity.

The final grade for the subject will be the average of the grades obtained in Parts 1 and 2.

The exam can be taken from the classrooms of the participating universities.

Warning: In cases of fraudulent performance in the tests (plagiarism or improper use of technology), the "Normativa de avaliación do rendemento académico dos estudantes e de revisión de cualificacións" (Regulations for the assessment of students' academic performance and revision of qualifications) will apply.

**CRITERIA FOR THE 2ND ASSESSMENT OPPORTUNITY**

The criteria are the same as those considered at the first opportunity.