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: Patricia Barral Rodiño [patricia.barral@usc.es]

UNIVERSITY WHERE THE LECTURER 1 IS: USC

HAVE YOU GIVEN PERMISSION TO RECORD YOUR CLASSES? Yes

SUBJECT CONTENTS:

1. Linear elastodynamic equations.
2. Stresses and strains.
3. Strain tensor.
4. General methods of resolution in linear elasticity.
5. Plane problems in linear elasticity.
6. Axially symmetric problems.
7. Bending and torsion of cylindrical beams.
8. One-dimensional beam models.
9. Plate models.
10. Vibrations.
11. Thermoelasticity. Anisotropic elasticity.
12. Plasticity.

13. Non linear boundary conditions.

METHODOLOGY

The classes will be given by videoconference, supported by a digital presentation and by COMSOL software package. A course will be available on the Virtual Campus of the Universidade de Santiago de Compostela and a team on the Teams platform to facilitate virtual tutorials.
Throughout the bimester, a progress virtual test and an individual work will be proposed, which will be taken into account in the evaluation of personal work.
The course will have besides book and video notes that will facilitate its study; this makes possible to realize an online modality, although it is necessary to take the progress test, present the individual work proposed during the bimester, and undergo the final evaluation test.
In addition to the bibliography indicated, we will handle recent publications in scientific journals.

LANGUAGE USED IN CLASS: Spanish; the language will be adapted depending on the audience.

IS IT COMPULSORY TO ATTEND CLASS? Videoconference. No in-person presence required.

BIBLIOGRAPHY

• Basic bibliography:

- Barral, P. Mathematical Models in Solid Mechanics. Volume II. Further Models in Elasticity and Plasticity. Repositorio MINERVA. Universidade de Santiago de Compostela, Departamento de Matemática Aplicada. 2025. https://hdl.handle.net/10347/42359.
- Bower, A.F. Applied Mechanics of Solids. CRC Press. 2010.
- Quintela, P. Modelos Matemáticos en Mecánica de Sólidos. Tomo I. Elasticidad Lineal. Repositorio MINERVA. Universidade de Santiago de Compostela, Departamento de Matemática Aplicada. 2025. https://hdl.handle.net/10347/42358.

• Complementary bibliography:

- Andersson, L.E. et al. “Non Smooth Mechanics and Analysis”. In: Springer, 2006. Chap. Thermoelastic contact with frictional heating, pp. 61–70.
- Barber, J.R. Elasticity. Solid Mechanics and its applications. Kluwer Academic Publishers. 2002.
- Bermúdez de Castro, A. Continuum Thermomechanics. Progress in Mathematical Physics. Edit. Birkhäuser. 2005.
- Chapman, A.J. Fundamentals of Heat Transfer. Macmillan Publish-ing Company, 1987
- Chaves, E.W.V. Mecánica del Medio Continuo. Conceptos Básicos. Centro Internacional de Métodos Numéricos en Ingeniería (CIMNE), Barcelona. 2012.
- Chaves, E.W.V. Mecánica del Medio Continuo. Modelos Constitutivos. Centro Internacional de Métodos Numéricos en Ingeniería (CIMNE), Barcelona. 2009.
- Ciarlet, P.G. Élasticité Tridimensionnelle. Masson.1985.
- Ciarlet, P.G. and Rabier, P. Les Equations de von Kármán. Lecture Notes in Mathematics, 826. Springer-Verlag. 1980.

- Fraeijs de Veubeke. A Course in Elasticity. Applied Mathematical Sciences, 29. Springer-Verlag 1979.
- Gurtin, M.E. An Introduction to Continuum Mechanics. Academic Press. New York, 1981.
- Gurtin M.E., Fried, E. and Anand L. The Mechanics and Thermodynamics of Continua. Cambridge University Press. 2010.
- Henry, J.P. and Parsy, F. Cours d'Élasticité. Dunod Université. 1982.
- Hill, R. The Mathematical Theory of Plasticity. Oxford University Press, 1983.
- Kikuchi, N. and Oden, J.T. Contact Problems in Elasticity: A Study of Variational Inequalities and Finite Element Methods. Siam, 1998.
- Lemaitre, J. and Chaboche, L.L. Mechanics of Solid Materials. Cambridge University Press, 1994.
- Moreno, C. Plasticidad en Sólidos. Curso de Doctorado. Universidad de Santiago de Compostela, 1997
- Negahban. Vibrations of cantilever beams: deflection, frecuency and research uses. 1999. http://em-ntserver.unl.edu/Mechanics-Pages/ScottWhitney/325hweb/Beams.htm
- Sokolnikoff, I.S. Mathematical theory of elasticity. Krieger Publishing Company. 1956.
- de Souza Neto, E.A., Peric, D. and Owen, D.R.J. Computational Methods for Plasticity. Theory and applications. Wiley, 2008.
- Vinson, J.R. The Behavior of Thin Walled Structures, Beams, Plates and Shells. Kluwer academic publishers. 1989.
- Wriggers, P. Computational Contact Mechanics. Springer, 2006.

SKILLS

General:

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 industrial mathematics.

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.

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 to be able to successfully undertake doctoral studies.

Specific:

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.

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

Modelling specialization:

CM1: To be able to extract, using different analytical techniques, both qualitative and quantitative information from the models.

CM2: Knowing how to model elements and complex systems leading to well-posed formulated problems.

The aforementioned competencies will be worked through:

Lectures : CE1, CE2, CE5, CM1, and CM2.

Seminars: CE1, CE2, CE5, CM1 and CM2.

Numerical simulation of practical cases: CE1, CE2, CE5, CM1 and CM2.

Personal homework: CG1, CG2, CG4, CG5, CE1, CE2, CE5, CM1 and CM2.

WILL YOU BE USING A VIRTUAL PLATFORM? Yes. USC Virtual Campus (Moodle). The course will have a Teams channel to facilitate virtual tutoring.

WILL YOU BE USING ANY SPECIFIC SOFTWARE? Yes. COMSOL Multiphysics.

CRITERIA FOR THE 1ST ASSESSMENT OPPORTUNITY

The grade of the personal work will be the average of the marks obtained in a virtual progress test and for the individual work carried out during the bimester. This work will be presented for assessment, either in person or by videoconference. The exam will be face-to-face, in the classroom assigned for this purpose at each master's degree location, and will comprise a virtual multiple-choice test and a written part. In order to pass the subject, it is essential to obtain at least 4 points out of 10 in the exam. The final grade will be the higher of the exam grade and the result of weighting the personal work at 40% and the exam at 60%.

The grade will be considered as not presented if the student did not take the progress test in continuous assessment, did not submit the individual work, and did not take the exam.

In cases of fraudulent performance in exercises or tests, the provisions of the University of Santiago de Compostela Regulations on the Assessment of Academic Performance and Qualifications will apply.

Competencies CG1, CG2, CG4, CG5, CE1, CE2, CE5, CM1 and CM2 will be evaluated through the personal homework.

Competencies CE1, CE2, CE5, CM1 and CM2 will be assessed by the final exam.

CRITERIA FOR THE 2ND ASSESSMENT OPPORTUNITY

In the second evaluation opportunity the student keeps the grade obtained with their personal work throughout the course. The final grade of the second opportunity will be governed by the same criteria as the first opportunity.
