



COURSE GUIDE

2025/26

Faculty 363 - Faculty of Engineering - Bilbao

Cycle .

Degree GMECAN30 - Bachelor`s Degree in Mechanical Engineering

Year Third year

COURSE

27722 - Elasticity and Strength of Materials

Credits, ECTS: 9

COURSE DESCRIPTION

Elasticity and Strength of Materials is a specific subject of Mechanical Engineering, which deals with the behavior of real solid bodies (deformable) subjected to various types of load. This subject provides students with fundamental knowledge for the analysis and design mechanical and structural systems (such as machines, industrial constructions, mechanisms, etc.). The subject provides the necessary knowledge to analyze the stress and deformation states in resistant mechanical elements.

It is, therefore, an essential basis for the subjects "Machine Design" and "Industrial Structures and Constructions" that are taught in the 2nd semester in the curriculum of the Degree in Mechanical Engineering.

To face this subject without excessive difficulty, it is necessary to follow the sequence of subjects foreseen in the curriculum and therefore, it is considered essential to have passed the following subjects:

- Physical fundamentals of engineering
- Algebra
- Calculus
- Applied Mechanics, mastering:
 - + Concepts related to static equilibrium,
 - + Obtaining of the internal forces in a cross section (axial, shear and bending) and establishment of diagrams.

COMPETENCIES/LEARNING RESULTS FOR THE SUBJECT

Competences in Specific Technology, Mechanical Module:

Knowledge and skills to apply the fundamentals of the elasticity and strength of materials to the behavior of real solids.

Learning outcomes/results:

- Know, understand and apply the fundamentals of the elasticity and strength of materials to the behavior of real solids that enable the student for the subsequent application of advanced methods and theories in his/her professional development, in areas of mechanical engineering; and likewise, give him/her a great versatility to adapt to new situations.
- Apply adequately the strategies of the scientific methodology to the problems posed by the structural systems and deformable solid: analyze the situation qualitatively and quantitatively, raise hypotheses and solutions to solve problems typical of mechanical engineering.
- Express, using the appropriate means, the theoretical knowledge, methods of resolution, results and aspects inherent to the problems posed by the balance of the deformable solid and structural systems, using the specific vocabulary and terminology.
- Work effectively as a group integrating skills and knowledge to formulate ideas, discuss proposals and adopt decisions in the development of works typical of the elasticity and strength of materials.
- Carry out measurements, calculations, studies, reports and other analogous work related to problematic situations that may arise in the field of elasticity and strength of materials.

Theoretical and Practical Contents

The contents to be developed will be established according to the following sections:

1. Introduction.

Scope of the subject. The Elasticity and Strength of Materials. Forms of the elements of the structures. Hypothesis about the nature of the bodies under study. Basic stages in the analysis of a structure. Hypothesis about deformations.

2. Concept of tension.

Internal forces. Concept of stress. Field of stresses. Main stresses. Graphic representation of the tensioner of stresses. Circles of Mohr. Special stress states.



3. General theory of deformation.

Hooke's law for a state of uniaxial tensile. Deformations due to shear stresses. Hooke's Law in shear. Hooke's law for flat stress and triaxial state of stresses. Deformation matrix. Circle of Mohr for flat deformation.

4. The elastic problem.

Flat elasticity. State of flat deformation. Flat stress state. Circle of Mohr.

5. The elastic solid.

Constitutive equations. The tensile test. Linear elasticity and Hooke's law. Shear stress and angular deformation. Generalized Hooke's Law. Deformations and stresses of thermal origin.

6. Failure theories.

Failure theories. Equivalent stress. Criterion of the maximum main stress or Rankine's criterion. Theory of maximum unit deformation or Saint-Venant's criterion. Theory of maximum tangential stress or Tresca's criterion. Theory of distortion energy (von Mises's criterion). Mohr's criterion.

7. Introduction to the Strength of Materials.

The prismatic piece. Internal forces and deformations; Navier's hypothesis. Isostatic beams and hyper-static beams. Diagrams of efforts.

8. Simple axial effort.

Tensile or compression simple stress state. Deformations in tensile or simple compression. Hyper-static structures. Effect of temperature and deformations or previous stresses.

9. General theory of bending. Stresses.

Normal deformations in beams. Normal stresses in beams. Types of beam sections. Shear stresses in rectangular beams. Shear stresses in double-T beams with wide wings. Shear stresses in circular beams. Compound beams. Beams with axial loads. Asymmetric bending.

10. General theory of bending. Deformations.

The elastic curve. Moment area method: Mohr's theorems. Application of the superposition principle.

11. Hyper-static bending.

Degree of hyper-staticity and static redundancy. General procedure using Mohr's theorems. General procedure using the differential equation of the elastic. Equation of the three moments. Singular cases in the equation of the three moments. Introduction to the study of rigid knot structures.

12. Theory of torsion.

Torsion in circular bars. Non-uniform torsion. Pure shear. Relationship between the modulus of elasticity E and G. Power transmission on axes. Bending and torsion combined in circular axes. Statically indeterminate axes in torsion.

13. Instability: Buckling.

Critical load. Euler's formulas. Anchorage conditions in columns. Field of application of Euler's formula.

TEACHING METHODS

The lectures will be expository and will develop the concepts and theoretical contents necessary to overcome successfully the subject. Model exercises will also be presented by the teacher.

The seminars are fundamental, given the applied nature of the subject; in them, students should work on problems of practical application. In these classes, group work and active participation of the students will be encouraged.

In case that sanitary conditions prevent the performance of any of the teaching activities and / or face-to-face assessment, a non-face-to-face modality would be activated of which the students would be informed promptly.

TYPES OF TEACHING

Types of teaching	M	S	GA	GL	GO	GCL	TA	TI	GCA
Hours of face-to-face teaching	60	30							
Horas de Actividad No Presencial del Alumno/a	90	45							

Legend: M: Lecture-based S: Seminar GA: Applied classroom-based groups
 GL: Applied laboratory-based groups GO: Applied computer-based groups GCL: Applied clinical-based groups
 TA: Workshop TI: Industrial workshop GCA: Applied fieldwork groups



Evaluation methods

- End-of-course evaluation

Evaluation tools and percentages of final mark

- Written test, open questions 80%
- Exercises, cases or problem sets 20%

ORDINARY EXAMINATION PERIOD: GUIDELINES AND OPTING OUT

The evaluation of the competences will be done through two partial exams and/or a final exam, which will represent 70% of the final grade in the subject. The remaining 30% will comprise the note of the deliverables that will be developed throughout the semester. In total, exam and deliverables, it must be obtained an average grade higher than 5.0 in order to be considered the subject as approved.

Throughout the semester, there will be two partial exams, which will allow to free final exam, both in the ordinary and in the extraordinary call, the passed part. In these partial exams, it must be achieved at least 40% of the maximum grade, in order to maintain the qualification and make the average with the part evaluated in the final exam, which must also reach at least 40% of the maximum grade of the part evaluated.

During the semester, various deliverables will be evaluated, in which a minimum score of 40% must be achieved (in each of them) of the maximum grade to be considered as surpassed. There will be three opportunities to overcome these deliverables (during the semester, ordinary and extraordinary calls).

The student will be qualified in any the ordinary and the extraordinary calls if he / she attends any of the final exams in these calls.

EXTRAORDINARY EXAMINATION PERIOD: GUIDELINES AND OPTING OUT

The final evaluation in this call will also be divided into a test that will represent 70% of the grade and in three deliverables with a percentage of 30% (in both parts a minimum qualification of 40% of the maximum note). In total, exam and deliverables, the students must obtain an average grade higher than 5.0 to be able to consider the subject as approved.

MANDATORY MATERIALS

Available in: <https://egela.ehu.es/>

BIBLIOGRAPHY

Basic bibliography

MECÁNICA DE MATERIALES. James M. Gere y Stephen P. Timoshenko. International Thomson Editores. 1998.
MECÁNICA DE MATERIALES. Ferdinand P. Beer y E. Russell Johnston, Jr. Mc. GRAW-HILL. 1993. RESISTENCIA DE MATERIALES. Manuel Vázquez. Editorial Noela. 1994.
RESISTENCIA DE MATERIALES. Luís Ortiz Berrocal. Universidad Politécnica de Madrid. 1980

Detailed bibliography

ANÁLISIS ESTRUCTURAL. R.C. Hibbeler. Prentice Hall Hispanoamerica, S.A. 1997.
MECÁNICA DE MATERIALES. Egor P. Popov y Toader A. Balan. Pearson Educación. 2000.
MECÁNICA DE MATERIALES. Anthony Bedford y Kenneth M Liechti. Prentice Hall. 2000.
MECÁNICA DE SÓLIDOS. William B. Bickford. Irwin. 1995.
ELASTICIDAD Y RESISTENCIA DE MATERIALES. José Luis Alcaraz, Rubén Ansola, Javier Canales, José A. Tárrago, Estrella Veguería. Sección de Publicaciones de la E.T.S.I. de Bilbao, 2012.

Journals

Web sites of interest

OBSERVATIONS