Elasticity and strength of materials

Academic Year: (2023 / 2024) **Review date: 12/02/2024 13:12:57**

Department assigned to the subject: Continuum Mechanics and Structural Analysis Department

Coordinating teacher: BARBERO POZUELO, ENRIQUE

Type: Compulsory ECTS Credits : 6.0

Year : 4 Semester : 1

REQUIREMENTS (SUBJECTS THAT ARE ASSUMED TO BE KNOWN)

We strongly advise you not to take this course if you have not passed

- Mecánica de Estructuras
- Cálculo I y II
- Álgebra

LEARNING OUTCOMES

CB1. Students have demonstrated possession and understanding of knowledge in an area of study that builds on the foundation of general secondary education, and is usually at a level that, while relying on advanced textbooks, also includes some aspects that involve knowledge from the cutting edge of their field of study.
CB2. Students are able to apply their knowledge to their work or vocation in a professional manner and possess the competences usually demonstrated through the development and defence of arguments and problem solving within their field of study.
CB3. Students have the ability to gather and interpret relevant data (usually within their field of study) in order to make judgements which include reflection on relevant social, scientific or ethical issues.
CB4. Students should be able to communicate information, ideas, problems and solutions to both specialist and non-specialist audiences.
CB5. Students will have developed the learning skills necessary to undertake further study with a high degree of autonomy.
CG2. Learn new methods and technologies from basic scientific and technical knowledge, and being able to adapt to new situations.
CG3. Solve problems with initiative, decision making, creativity, and communicate and transmit knowledge, skills and abilities, understanding the ethical, social and professional responsibility of the engineering activity. Capacity for leadership, innovation and entrepreneurial spirit.
CG4. Solve mathematical, physical, chemical, biological and technological problems that may arise within the framework of the applications of quantum technologies, nanotechnology, biology, micro- and nano-electronics and photonics in various fields of engineering.
CG5. Use the theoretical and practical knowledge acquired in the definition, approach and resolution of problems in the framework of the exercise of their profession.
CG6. Develop new products and services based on the use and exploitation of new technologies related to physical engineering.
CG7. Undertake further specialized studies, both in physics and in the various branches of engineering.
CE9. Understand and handle the fundamentals of materials science, technology and chemistry, as well as the relationship between microstructure, synthesis or processing and the properties of materials.
CT1. Work in multidisciplinary and international teams as well as organize and plan work making the right decisions based on available information, gathering and interpreting relevant data to make judgments and critical thinking within the area of study.

RA1. To have acquired sufficient knowledge and proved a sufficiently deep comprehension of the basic principles, both theoretical and practical, and methodology of the more important fields in science and technology as to be able to work successfully in them.
RA2. To be able, using arguments, strategies and procedures developed by themselves, to apply their knowledge and abilities to the successful solution of complex technological problems that require creating and innovative thinking.

RA3. To be able to search for, collect and interpret relevant information and data to back up their conclusions including, whenever needed, the consideration of any social, scientific and ethical aspects relevant in their field of study.
RA4. To be able to successfully manage themselves in the complex situations that might arise in their academic or professional fields of study and that might require the development of novel approaches or solutions.
RA6. To be aware of their own shortcomings and formative needs in their field of specialty, and to be able to plan and organize their own training with a high degree of independence.

DESCRIPTION OF CONTENTS: PROGRAMME

CHAPTER 1. INTRODUCTION TO SOLID MECHANICS
Subject 1: Kinematic of deformable bodies
- Motion: Basic concepts
- Strain Tensor
- Infinitesimal strain
- Geometrical meaning of the components of infinitesimal strain tensor
- Principal Strains
- Equations of compatibility

Subject 2: Equilibrium in deformable bodies
- Body and surface forces
- Concept of stress
- Stress tensor
- Stress equations of equilibrium
- Stationary stresses

Subject 3: Constitutive equations
- Behaviour laws
- Hyperelastic behaviour
- Linear elastic behaviour
- Material symmetries
- Physical meaning of the constants

CHAPTER 2. INTRODUCTION TO ELASTICITY
Subject 4: Formulation of Elasticity equations
- Elasticity equations
- Boundary and contact conditions
- Displacement and Stress formulations
- Theorems and general principes.

Subject 5: Two dimensional theory of Elasticity
- Plain Stress and Plain Strain
- Plane Elasticity in term of displacement
- Plane Elasticity in terms of stresses
- Methods of solutions
- Mohr´s circle in 2D
- Elasticity in polar coordinates
- Plane Elasticity in term of displacement
- Plane Elasticity in terms of stresses

Subject 6: Failure criteria
- Failure by yielding
- Plastification criteria
- Equivalent stress and safety factor

CHAPTER 4. INTRODUCTION TO STRENGTH OF MATERIALS

Subject 7: Bending in beams
- Fundamentals concepts
- External and internal forces
- Equilibrium equations
- Kinematic hypotheses
- Normal stresses in beams
- Neutral axis
- Shear stresses

- Sections with symmetries

Subject 8: Torsion
- Kinematic hypotheses
- Displacement formulation
- Stress formulation
- Circular cross sections
- Thin-walled cross-sections

Subject 9: Deflections of beams
- Equilibrium equations of beams
- Internal forces and moments equations
- Deflections by integration of the internal forces- and moment-equations (Navier-Bresse equations)
- Moment-area method(Mohr´s theorems)

Subject 10: Analysis of hyperstatic beams
- Differential equation of the deflection curve (Euler and Timoshenko beams)
-- Kinematic definitions
- Static definitions
- Introduction to the displacement (or stiffness) method

LEARNING ACTIVITIES AND METHODOLOGY

In each week one lecture session (master class) and one practical session (in reduced groups) will be taught. The first is geared to the acquisition of theoretical knowledge, and the second to the acquisition of practical skills related to theoretical concepts. In addition to this sessions four laboratory practical sessions in reduced groups (maximum 20 students) will be impart.
Students will have the possibility of individual tutorials.

ASSESSMENT SYSTEM

% end-of-term-examination/test:	60
% of continuous assessment (assigments, laboratory, practicals…):	40

Final exam (obligatory): 60%
Continuum evaluation: 40%

Laboratory practicals: 15% (obligatory)
Class participation (Wooclaps): Up to 5%.
Continuous assessment test: 20%

If the mark obtained in the final exam is lower than 4.5, the final mark of the student will be computed only with the final exam
To pass the subject, attendance and completion of the laboratory sessions are mandatory.

BASIC BIBLIOGRAPHY

- Barber, J.R. Elasticity, Kluwer Academic Publishers, 1992

- F.P. Beer, E.R. Johnston, J.T. DeWolf, D.F. Mazurek. Mechanics of Materials, McGraw-Hill., 2013

- J.M. Gere, S. Timoshenko. Mechanics of Materials, Cengage Learning, 2009

ADDITIONAL BIBLIOGRAPHY

- Benham, P.P. y Crawford, R.J. Mechanics of engineering materials, Longman Scientific & Technical, 1987

- Chung T.J. Applied continuum mechanics, Cambridge University Press, 1996

- Shames, I.H. y Cozzarelli, F.A. Elastic and inelastic stress analysis, CRC Press, 1997

- Wunderlich, W. y Pilkey, W.D. Mechanics of structures: Variational and Computanional Methods, CRC Press. , 1992