Solid Mechanics

Academic Year: (2023 / 2024) **Review date: 21/04/2023 10:54:15**

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

Coordinating teacher: ARANDA RUIZ, JOSUE

Type: Electives ECTS Credits : 6.0

Year : 4 Semester : 1

REQUIREMENTS (SUBJECTS THAT ARE ASSUMED TO BE KNOWN)

-- Elasticity
-- Mechanics of Structures

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.
CB5. Students will have developed the learning skills necessary to undertake further study with a high degree of autonomy.
CG1. Ability to solve problems with initiative, decision-making, creativity, critical reasoning and to communicate and transmit knowledge, skills and abilities in the field of Industrial Engineering.
CG3. Ability to design a system, component or process in the field of Industrial Technologies to meet the required specifications
CG4. Knowledge and ability to apply current legislation as well as the specifications, regulations and mandatory standards in the field of Industrial Engineering.
CG5. Adequate knowledge of the concept of company, institutional and legal framework of the company. Organisation and management of companies.
CG6. Applied knowledge of company organisation.
CG8. Knowledge and ability to apply quality principles and methods.
CG9. Knowledge and ability to apply computational and experimental tools for the analysis and quantification of Industrial Engineering problems.
RA1. Knowledge and understanding: Have basic knowledge and understanding of science, mathematics and engineering within the industrial field, as well as knowledge and understanding of Mechanics, Solid and Structural Mechanics, Thermal Engineering, Fluid Mechanics, Production Systems, Electronics and Automation, Industrial Organisation and Electrical Engineering.
RA2. Engineering Analysis: To be able to identify engineering problems within the industrial field, recognise specifications, establish different resolution methods and select the most appropriate one for their solution
RA3. Engineering Design: To be able to design industrial products that comply with the required specifications, collaborating with professionals in related technologies within multidisciplinary teams.
RA4. Research and Innovation: To be able to use appropriate methods to carry out research and make innovative contributions in the field of Industrial Engineering.
RA5. Engineering Applications: To be able to apply their knowledge and understanding to solve problems and design devices or processes in the field of industrial engineering in accordance with criteria of cost, quality, safety, efficiency and respect for the environment.

OBJECTIVES

By the end of this course, students will be able to:
1. Understand the criteria that establish the limit of classical elasticity, the behavior of materials in elasto-plastic regime and the constitutive equations that determine this relationship.
2. Analyze the response of advanced materials that incorporate viscoelastic and viscoplastic behavior.
3. Apply its knowledge and understanding to identify, formulate and solve problems of calculation and design of components that require incorporating the inelastic behaviour of materials, by means of the use of specifically established methods.
4. Apply both analytical and numerical resolution methods in the calculation of structural problems with visco-elastic-plastic materials.
5. Apply the acquired knowledge to interpret experimental results, and to carry out designs of structural components that meet specific requirements.
6. Understand and use in an appropriate way the different methods that exist to characterize and analyze the mechanical response of materials with visco-elastic-plastic behavior.
7. Design and carry out experiments for the characterisation of materials with inelastic behaviour, as well as to interpret the data and draw conclusions.
8. Obtain technical and laboratory skills.
9. Have the ability to select and use the appropriate tools and methods to characterize materials with viscoelastic-plastic behavior.
10. Acquire the ability to combine theoretical concepts and practical exercises to solve problems involving mechanical and/or structural components in which it is required to use materials with inelastic behavior.
11. Understand the methods, both analytical and numerical, that are used in the characterization and analysis of the behavior of visco-elastic-plastic solids; being aware of the existing limitations, mainly from the analytical point of view.

DESCRIPTION OF CONTENTS: PROGRAMME

Chapter 1. Introduction to Mechanical Behaviour of Materials (No. of sessions: 1)

Chapter 2. Equations of Solids Mechanics. Deformable Solid Kinematics (No. of sessions: 1)

Chapter 3. Plasticity (No. of sessions: 6)
-- Yield Criteria.
-- Strain Hardening.
-- 1D plasticity.
-- Equations of Plasticity. Incremental Theory of Plasticity.
-- The Finite Element Method in Plasticity.

Chapter 4. Viscoelasticity (No. of sessions: 2)
-- Phenomenology
-- Viscoelastic constitutive models based on linear analogies
-- Principle of Correspondence and Hereditary Integrals

Chapter 5. Viscoplasticity (No. of sessions: 2)
-- Phenomenology
-- Laws of stationary creep
-- Viscoplastic constitutive models based on non-linear analogies

Chapter 6. Introduction to Fracture Mechanics (No. of sessions: 1)
-- Introduction to Linear Elastic Fracture Mechanics.

LEARNING ACTIVITIES AND METHODOLOGY

Each week will be taught:
-- a master class session (in aggregate group), oriented to the acquisition of main theoretical concepts of the subject, through the use of IT and audiovisual support.
-- A session of resolution of exercises (in reduced group), oriented to the acquisition of practical skills related to the theoretical concepts of the magistral session.

In addition to this teaching, four laboratory sessions will be given at specific times in small groups (maximum 20 students).

Along with the activities mentioned, the FORMATIVE ACTIVITIES are completed with the work and personal study of the student, who will also have the possibility of requesting individual tutoring sessions in the corresponding timetable.

There will be an optional (at the request of the students) session of collective tutoring in the last week of the course, in the schedule assigned to the master session.

ASSESSMENT SYSTEM

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

The assessment of the subject is carried out in two parts: on the one hand, a Final Exam is carried out, consisting of a test that can involve both practical problems and conceptual questions and, on the other hand, there is a system of Continuous Evaluation, based on work, participation in class and partial tests of evaluation of skills and knowledge.

A MINIMUM NOTE of 4.5 is required at the FINAL EXAM of the course in order for the Continuous Evaluation to be taken into account in the final grade.

In order to pass the course, the attendance and performance of the laboratory practices foreseen in the weekly planning are compulsory. The weighting of the laboratory practice mark in the continuous assessment corresponds to what it is established in the course, in accordance with the regulations of the university. In the subject "Solids Mechanics", the weighting of the laboratory practices takes the value of 37,5% of the continuous assessment grade.

Weighting:

Case 1 - If the score on the Final Exam is equal to or higher than 4.5, then:

FINAL EXAM : 60%
CONT. EVAL. : 40% broken down as follows:

- Laboratory Practice Report : 15%
- Partial test of knowledge: 25%.

Case 2 - If the score on the Final Exam is lower than 4.5, then:

FINAL EXAM : 100%
CONT. EVAL. : 0%

BASIC BIBLIOGRAPHY

- Bertram, A. (Albrecht) Elasticity and plasticity of large deformations: an introduction, Berlin: Springer, 2008

- Dill, Ellis Harold Continuum mechanics: elasticity, plasticity, viscoelasticity, Boca Raton (Florida): CRC Press, 2007

- Lemaître, Jean Mécanique des matériaux solides, París: Bordas, 1988

- Ottosen & Ristinmaa The mechanics of constitutive modeling, Elsevier, 2005

BASIC ELECTRONIC RESOURCES

- Matweb . physical and mechanical properties of several materials: http://www.matweb.com/search/search.aspx

- Prof. Allan F. Bower (Brown University) . Course on Solid Mechanics: http://solidmechanics.org/

- Prof. Kelly (University of Auckland) . Mechanics Lecture Notes: http://homepages.engineering.auckland.ac.nz/~pkel015/SolidMechanicsBooks/