Mechanics of Structures

Academic Year: (2024 / 2025) **Review date: 03-09-2024**

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

Coordinating teacher: GARCIA GONZALEZ, DANIEL

Type: Compulsory ECTS Credits : 6.0

Year : 2 Semester : 1

SKILLS AND 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.
CG10. Being able to work in a multi-lingual and multidisciplinary environment
CE2 Módulo CRI. Knowledge and abilities to apply the fundamentals of elasticity and materials resistance to the behavior of real solid structures.
CE15 Módulo CRI. Theoretical and practical fundamentals for calculus of stresses in structures and of the motion of structural resistant elements subjected to different stresses.
CE18 Módulo CRI. Understanding of the relationship between the materials microstructure, synthesis or processing and their properties.
CT1. Ability to communicate knowledge orally as well as in writing to a specialized and non-specialized public.
CT2. Ability to establish good interpersonal communication and to work in multidisciplinary and international teams.
CT3. Ability to organize and plan work, making appropriate decisions based on available information, gathering and interpreting relevant data to make sound judgement within the study area.
CT4. Motivation and ability to commit to lifelong autonomous learning to enable graduates to adapt to any new situation.

By the end of this content area, students will be able to have:
RA1.1 knowledge and understanding of strength of materials and structural calculus.
RA1.2 a systematic understanding of the key aspects and concepts of mechanics of structures.
RA1.4 awareness of the wider multidisciplinary context of engineering.
RA2.1 the ability to apply their knowledge and understanding to identify, formulate and solve problems of strength of materials and structural calculus using established methods;
RA4.2 the ability to design and conduct appropriate experiments, interpret the data and draw conclusions;
RA4.3 workshop and laboratory skills.
RA5.1 the ability to select and use appropriate equipment, tools and methods;
RA5.2 the ability to combine theory and practice to solve problems of strength of materials and structural calculus
RA5.3 an understanding of applicable techniques and methods in mechanics of structures, and of their limitations;

OBJECTIVES

Upon successful completion of this course, students will be able to:
1. Have knowledge and understanding of the principles of strength of materials and structural calculus.
2. Be aware of the multidisciplinary context of industrial engineering.
3. Have the ability to apply their knowledge and understanding to identify, formulate and solve material strength and structural calculation problems using established methods.
4. Ability to design and perform experiments, interpret data and draw conclusions.
5. Have technical and laboratory skills.
6. Have the ability to select and use appropriate equipment, tools and methods.
7. Be able to combine theory and practice to solve problems of material strength and structural calculation.
8. Have an understanding of applicable methods and techniques and their limitations.

DESCRIPTION OF CONTENTS: PROGRAMME

I: BEHAVIOUR OF REAL BODY EQUILIBRIUM AND CALCULUS OF REACTIONS FOR STRUCTURAL MECHANICS
Topic 1: FORCE SYSTEMS AND EQUILIBRIUM
1.1 Main concepts
1.2 Force systems and equivalent force systems

Topic 2: REACTIONS FORCES
2.1 Computation of reactions in statically determinate structures
2.2 Computation of reactions in statically indeterminate externally structures

Topic 3: MASS GEOMETRY
3.1 Centre of mass of planar bodies
3.2 Moment of inertia of planar bodies

II: FORCE LAWS IN ISOSTATIC STRUCTURES
Topic 4: FORCE LAWS (I)
4.1 Concept and types of internal forces
4.2 Relationship between load, shear force and bending moment

Topic 5: FORCE LAWS (II)
5.1 Determination of internal forces in simple beams
5.2 Determination of internal forces in archs

Topic 6: FORCE LAWS (III)
6.1 Determination of internal forces for complex beams
6.2 Determination of internal forces for frames

III: TRUSS STRUCTURES AND CABLE STRUCTURES
Topic 7: TRUSSES
7.1 Internal forces for trusses
7.2 Resolution procedures

Topic 8: CABLES
8.1 Cables under concentrated loads
8.2 Cables under distributed loads

IV: CONCEPT OF UNIAXIAL STRESS AND UNIAXIAL STRAIN
RELATIONSHIP BETWEEN STRESS AND STRAIN IN ELASTIC SOLIDS
Topic 9: DEFORMABLE BODY
9.1 Main concepts. Cauchy stress
9.2 Mechanical behaviour of solids

V: PRINCIPLES OF STRENGTH OF MATERIALS. GENERAL STUDY OF STRUCTURAL BEHAVIOUR OF CROSS SECTION STRENGTH
Topic 10: TENSILE/COMPRESSION (I)
10.1 Principles of strength of materials
10.2 Tensile and compressive axial force

Topic 11: BENDING (II)
11.1 Strength of materials. Bending (I)
11.2 Pure bending

Topic 12: BENDING (III)
12.1 Strength of materials. Bending (II)
12.2 Complex bending

VI: INTRODUCTION TO EXPERIMENTAL METHODS FOR STRUCTURAL MECHANICS ENGINEERING APPLICATIONS

3 Laboratory sessions

LEARNING ACTIVITIES AND METHODOLOGY

- Master class, sessions of questions resolution in reduced groups, students presentations, individual sessions, and personal student work for theoretical knowledge (3 ECTS).

- Practical sessions of laboratory and sessions of problems in reduced groups, individual sessions, and personal student work for practical knowledge (3 ECTS).

Additionally, collective tutorship can be included in the programme.

ASSESSMENT SYSTEM

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

Continuum assessment systemm based on reports, class participation and skills and knowledge tests.

A minimum grade of 4.5 in the final exam (either ordinary or extraordinary exams) is required to take into account the continuum assessment.

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 Mechanics of Structures, the weighting of the laboratory practices takes the value of 37,5%(*) of the continuous assessment grade.

In this course, students should not use artificial intelligence tools to carry out the work or exercises proposed by the faculty. In the event that the use of AI by the student gives rise to academic fraud by falsifying the results of an exam or work required to accredit academic performance, the Regulation of the University Carlos III of Madrid of partial development of the Law 3/2022, of February 24th, of University Coexistence, will be applied.

BASIC BIBLIOGRAPHY

- Ferdinand Beer, Russell Johnston Vector Mechanics for Engineers, Vol. 1, Statics, Mc Graw Hill., 1994

- J. Case Strength of material and structures, Ed. Arnold, 1999

- J.M. Gere Mechanics of materials, Ed. Thomson, 2002

- W.M.C. McKenzie Examples in structural analysis, Taylor and Francis , 2006