Elasticity and strength of materials

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

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

Coordinating teacher: BARBERO POZUELO, ENRIQUE

Type: Electives ECTS Credits : 6.0

Year : Semester :

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.
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

Subject 1: Equilibrium in deformable bodies
- Body and surface forces
- Concept of stress
- Stress tensor
- Stress equations of equilibrium
- Stationary stresses

Subject 2: 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 3: Constitutive equations
- Behaviour laws
- Hyperelastic behaviour
- Linear elastic behaviour
- Material symmetries
- Physical meaning of the constants

Subject 4: Differential formulation
- Elasticity equations
- Boundary and contact conditions
- Displacement (Navier) formulation
- Stress (Michell-Beltrami) formulation

Subject 5: Integral formulation and principles (I)
- Theorem of Virtual Works
- Clapeyron theorem
- Theorem of Minimum Potential Energy

Subject 6: Integral formulation and principles (II)
- Reciprocity Theorems
- General Principles

Subject 7: Failure criteria
- Failure by yielding
- Haig-Westergaard representation
- Von Mises-Hencky-Nadai yield criterion
- Tresca-Guest yield criterion
- Alternate yield criteria
- Equivalent stress and safety factor

Subject 8: Two dimensional theory of Elasticity (I)
- 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

Subject 9: Two dimensional theory of Elasticity (II)
- Elasticity in polar coordinates
- Plane Elasticity in term of displacement
- Plane Elasticity in terms of stresses

Subject 10: Bending in beams
- Kinematic hypotheses
- Normal stresses in beams
- Neutral axis

Subject 11: Torsion
- Kinematic hypotheses
- Displacement formulation
- Stress formulation
- Circular cross sections

CHAPTER 5. DEFLECTIONS OF BEAMS (Nºof sessions: 3)

Subject 12: Deflections of beams (I)
- Equilibrium equations of beams
- Internal forces and moments equations
- Deflections by integration of the internal forces- and moment-equations (Navier-Bresse equations)

Subject 13: Deflections of beams (II)
- Moment-area method(Mohr¿s theorems)
- 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

AF1. THEORETICAL-PRACTICAL CLASSES. Knowledge and concepts students mustacquire. Receive course notes and will have basic reference texts.Students partake in exercises to resolve practical problems
AF2. TUTORING SESSIONS. Individualized attendance (individual tutoring) or in-group (group tutoring) for students with a teacher.Subjects with 6 credits have 4 hours of tutoring/ 100% on- site attendance.
AF3. STUDENT INDIVIDUAL WORK OR GROUP WORK.Subjects with 6 credits have 98 hours/0% on-site.
AF8. WORKSHOPS AND LABORATORY SESSIONS. Subjects with 3 credits have 4 hours with 100% on-site instruction. Subjects with 6 credits have 8 hours/100% on-site instruction.
AF9. FINAL EXAM. Global assessment of knowledge, skills and capacities acquired throughout the course. It entails 4 hours/100% on-site
AF8. WORKSHOPS AND LABORATORY SESSIONS. Subjects with 3 credits have 4 hours with 100% on-site instruction. Subjects with 6 credits have 8 hours/100% on-site instruction.
MD1. THEORY CLASS. Classroom presentations by the teacher with IT and audiovisual support in which the subject`s main concepts are developed, while providing material and bibliography to complement student learning
MD2. PRACTICAL CLASS. Resolution of practical cases and problem, posed by the teacher, and carried out individually or in a group
MD3. TUTORING SESSIONS. Individualized attendance (individual tutoring sessions) or in-group (group tutoring sessions) for students with teacher as tutor. Subjects with 6 credits have 4 hours of tutoring/100% on-site.
MD6. LABORATORY PRACTICAL SESSIONS. Applied/experimental learning/teaching in workshops and laboratories under the tutor's supervision.

ASSESSMENT SYSTEM

SE1. FINAL EXAM. Global assessment of knowledge, skills and capacities acquired throughout the course.The percentage of the evaluation varies for each subject between 60% and 0%.
SE2. CONTINUOUS EVALUATION. Assesses papers, projects, class presentations, debates, exercises, internships and workshops throughout the course.The percentage of the evaluation varies for each subject between 40% and 100% of the final grade.

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