Elasticity and strength of materials

Academic Year: (2023 / 2024) **Review date: 24/11/2023 14:25:24**

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

Coordinating teacher: BARBERO POZUELO, ENRIQUE

Type: Compulsory ECTS Credits : 6.0

Year : 3 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.
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
CG9. Knowledge and ability to apply computational and experimental tools for the analysis and quantification of Industrial Engineering problems.
CG19. Knowledge and use of the principles of strength of materials.
ECRT2. Knowledge and skills to apply the fundamentals of elasticity and strength of materials to the behaviour of real solids.
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
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.

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