Elasticity and strength of materials

Academic Year: (2020 / 2021) **Review date: 01-10-2020**

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

Coordinating teacher: BARBERO POZUELO, ENRIQUE

Type: Compulsory ECTS Credits : 6.0

Year : 3 Semester : 1

STUDENTS ARE EXPECTED TO HAVE COMPLETED

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

- Mecánica de Estructuras
- Cálculo I y II
- Álgebra

COMPETENCES AND SKILLS THAT WILL BE ACQUIRED AND LEARNING RESULTS.

Capacity to formulate the elasticity equations, to assess the hypotheses and to interpret the results.
Knowledge and application of principles of Strength of Materials
Knowledge of the basic techniques for Structural Analysis of deformable bodies.
Capacity of analysis and evaluation with critical sense of results of structural calculus

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

Subject 4: Failure criteria
- Failure by yielding
- Haig-Westergaard representation
- Von Mises-Hencky-Nadai yield criterion
- Tresca-Guest yield criterion
- Equivalent stress and safety factor

CHAPTER 2. INTRODUCTION TO ELASTICITY
Subject 5: Formulation of Elasticity equations (I)
- Elasticity equations
- Boundary and contact conditions
- Displacement (Navier) formulation
- Stress (Michell-Beltrami) formulation

Subject 6: Formulation of Elasticity equations (II)
- Theorem of Virtual Works
- Superposition Theorem
- Saint Venant´s principle

Subject 7: 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 8: Two dimensional theory of Elasticity (II)
- Elasticity in polar coordinates
- Plane Elasticity in term of displacement
- Plane Elasticity in terms of stresses

CHAPTER 4. INTRODUCTION TO STRENGTH OF MATERIALS

Subject 9: Bending in beams (I)
- Fundamentals concepts
- External and internal forces
- Equilibrium equations
- Kinematic hypotheses
- Normal stresses in beams

Subject 10: Bending in beams (II)
- Neutral axis
- Shear stresses
- Sections with symmetries

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

Subject 12: 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 13: 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

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

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. The weighting of the mark of the laboratory sessions in the continuous evaluation corresponds to what is established in the subject, in accordance with the university regulations. The weighting of laboratory sessions takes the value of 37.5% of the continuous assessment mark.

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

BASIC BIBLIOGRAPHY

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

- Garrido, J.A. y Foces, A. Resistencia de Materiales, Secretariado de Publicaciones. Universidad de

Valladolid, 1994

- Oliver, X.; Agelet, C. Mecánica de medios continuos para ingenieros, Edid. UPC, 2000

- Ortiz Berrocal, L Elasticidad, Ed. McGraw Hill, 1998

- Paris Carballo, F. Teoría de la elasticidad, Ed. Grupo de Elasticidad y Resistencia, 1998

- Samartin Quiroga, A. Resistencia de Materiales, Servicio de Publicaciones. Colegio de Ingenieros de Caminos, canales y Puertos, 1995

- Sanmartín Quiroga, A. Curso de Elasticidad, Ed. Bellisco, 1990

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

- Doblaré Castellano, M. y Gracia Villa, L. Fundamentos de la Elasticidad Lineal, Ed. Síntesis, 1998

- 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