

Academic Year: ( 2022 / 2023 )

Review date: 04-06-2021

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

Coordinating teacher: BARBERO POZUELO, ENRIQUE

Type: Compulsory ECTS Credits : 6.0

Year : 4 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

**OBJECTIVES**

- RA1 Knowledge and Understanding
- RA2 Engineering Analysis
- RA3 Engineering Design
- RA4 Investigations
- RA5 Engineering Practice
- RA6 Transferable Skills
- CB1
- CB2
- CG1
- CG3
- CG9
- CG19
- ECRT2

**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.

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|---|----|
| <b>% end-of-term-examination:</b>   | 60 |
| <b>% of continuous assessment (assignments, laboratory, practicals...):</b> | 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 Computational Methods, CRC Press. , 1992