Composite Materials Structures (250703)

General information

School:	ETSECCPB
Departments:	Departament d'Enginyeria Civil i Ambiental (DECA), Departament de Ciència i Enginyeria Nàutiques (CEN)
Credits:	5.0 ECTS
Programs:	MÀSTER UNIVERSITARI EN ENGINYERIA DEL TERRENY, pla 2015 - (codi pla 1141), MÀSTER UNIVERSITARI EN ENGINYERIA ESTRUCTURAL I DE LA CONSTRUCCIÓ, pla 2015 - (codi pla 1140)
Course:	2015/2016
Course language:	Castellano

Faculty

Responsible faculty: Sergio Horacio Oller Martinez

Teachers: Javier Martinez Garcia, Sergio Horacio Oller Martinez

Generic objectives

Subject to know the behavior and calculation of structures made of composite materials

Capability to design and calculate structures made of composite materials. Ability to interpret results from finite element programs appropriate for non - linear analysis of composite structures

Introduction, definition and use of some composite materials. Anisotropy of the material. Theory of Mixtures : Slide fiber matrix (DFM) . Delamination of laminated composite . Homogenization theory . Reinforced composites inelastic buckling. Fuselage and wing structures tickets compounds and mixed materials (aluminum - composite) . Repair and reinforcement of structures with composite materials

The aim of this course is to get students to acquire extensive information about the behavior and calculation of structures built in composite materials. It is also expected that these studies will allow interpreting results from appropriate programs for non-linear analysis of composite structures finite elements. The study of this subject is discussed under the assumption that the structures can achieve cinematic nonlinear constitutive behavior and / or. To numerically analyze the behavior of structures, two basic theories will be studied: 1) blends theory and its various evolutions and 2) the theory of homogenization and its various forms. Some nonlinear constitutive models will also be remembered for representing the behavior of each basic substance.

Skills

Specific skills

To conceive and design civil and building structures that are safe, durable, functional and integrated into its surroundings.

Designing and building using traditional materials (reinforced concrete, prestressed concrete, structural steel, masonry, wood) and new materials (composites, stainless steel, aluminum, shape memory alloys?).

Mathematically modelling structural engineering problems.

To apply methods and advanced design software and structural calculations, based on knowledge and understanding of forces and their application to the structural types of civil engineering.

Generic skills of subject

To conceive, design, analyze and manage structures or structural elements of civil engineering or building, encouraging innovation and the advance of knowledge.

To develop, improve and use conventional materials and new construction techniques to ensure the safety requirements, functionality, durability and sustainability.

ECTS credits: total hours of student work

		Dedication	
		Hours	**Percent**
Supervised Learning	**Theory**	24.50	54.4%
	Assignments	12.50	27.8%
	Laboratory	8.00	17.8%
	Supervised activities	0.00	0.0%
Self-Learning		105.00	

Contents

Introduction, definition and use of some composite materials

Dedication

2.0h. Theory

Description

Use of composite materials: in the automotive industry, in the aircraft industry, in shipbuilding, in civil engineering. Properties of Compounds. Achievable features. Classification of composite materials. Classification by topology. Classification according to its components. Structural Classification.

Anisotropy of the material

Dedication

2.5h. Theory + 1.5h. Assignments + 1.0h. Laboratory

Description

Overview of anisotropic formulation. General definition of explicit criteria orthotropic creep in the benchmark setting. General definition of an orthotropic approach implicit in the reference configuration. Anisotropy in the updated configuration.

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Mixing Theory

Dedication

2.5h. Theory + 1.5h. Assignments + 1.0h. Laboratory

Description

Classical Mixing Theory mixtures. Modification classical theory. Series-parallel. Model Generalized theory mixtures. Classical theory formulated mixtures large strain. Generalized theory formulated mixtures large strain. Modifying mixing theory for reinforcing short length. Constitutive equation of the composite. Comparison "micropattern" vs. "Theory of Mixtures" with large deformation anisotropy. Application to various engineering problems

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Fiber-matrix debounding

Dedication

2.5h. Theory + 1.5h. Assignments + 1.0h. Laboratory

Description

Stress distribution along the reinforcing fiber. Interaction between cracks and fibers. Constitutive models for composite materials with "DFM". Implementation. Lagrangian formulation "Total" and "Update". Implementation of mixing theory and anisotropy in the context of "MEF". Phenomenon "DFM" micropattern blends theory and anisotropy.

Fiber-matrix debounding (DFM) (Class 1.5)

Delamination of laminated composites

Dedication

2.5h. Theory + 1.5h. Assignments + 1.0h. Laboratory

Description

Identification of the phenomenon. Defining the formulation. Coupling with the formulation of the theory of mixtures in small and large deformations.

Delamination in laminated composites (Class 1.5)

Homogenization Theory

Dedication

3.5h. Theory + 2.0h. Assignments + 1.0h. Laboratory

Description

Introduction and state of knowledge. Averages methods. Theory asymptotic expansion. Extension of the "average method" and "Asymptotic Expansion Method" to the nonlinear problem. Other issues related to standardization. Boundary conditions and implementation. Two scales solution elastic problem. Challenges to the theory of homogenization and use of adaptive methods and "multi-grid". Homogenization by Voronoi Finite Element Method. Theory based on "Local Recurrence" homogenization. Concepts on the periodic structure. Local Frequency of variables. Effect of periodic field trips. Homogenization of the strain tensor. The homogenized voltage and the equilibrium equation. Fundamentals of elastic problem in the micro-macro scales. Micro-Macro structural coupling. Influence of local effects. Application to various problems: reinforced laminates, masonry, etc.

Theory homogenisation (Class 2.0)

Inelastic buckling reinforced composites

Dedication

2.5h. Theory + 1.5h. Assignments + 1.0h. Laboratory

Description

Introduction. Description of the phenomenon. Euler critical load. Model of Rosen. Micro-mechanical models. Finite element formulation. Simplified formulation. Models of mechanical damage. Loss model buckling stiffness of the compounds with long fibers. General definition for fiber reinforced composites. Definition of variable stiffness loss buckling: Participation of the fiber matrix participation. Energy dissipation.

Inelastic buckling in reinforced composites (class 1.5)

Fuselage and wing structures of aircraft composite materials

Dedication

2.5h. Theory + 1.5h. Assignments + 1.0h. Laboratory

Description

Introduction. Different structural designs in composite materials and structural evaluation of the same: simplified solution, finite element solution

Fuselage and wing structures of aircraft composite materials (Class 1.5)

Strengthening and repair of structures with composite materials

Dedication

4.0h. Theory + 1.5h. Assignments + 1.0h. Laboratory

Description

Introduction. Possible solutions for structural reinforcement of beams and concrete frames. Repair and effectiveness of possible solutions. Calculation and evaluation of reinforcements and repairs.

Repair and reinforcement of structures with composite materials (Class 2.0)

Activities

Grading rules (*)

(*) The evaluation calendar and grading rules will be approved before the start of the course.

The course grade is obtained from continuous assessment grades and measurable practical work on each of the topics.

The rating of the asignutura results from the average of the marks of the papers presented.

Work will be done using tools like MathCad and/or Matlab and/or using Finite Element programs that provide students

Test rules

If any or practical work continuous assessment in the scheduled period is performed it shall be considered as zero score.

Teaching methodology

This course takes place in 14 classes of three hours each. Each class will have about 1:30 hours devoted to theoretical dictates of the same i 0:30 discussions and consultations. Also, 13 hours were devoted to the development of work / problems implementing some topics of the course, and 8 hours of work evaluation.

Support material is used in the form of detailed teaching plan using the virtual campus ATENEA: content, programming and evaluation activities directed learning and literature.

Office hours

At the end of each class

Basic bibliography

- Sergio Oller. **Numerical Simulation of Mechanical Behavior of Composite Materials.**. Springer - CIMNE. 2014.

- R. M. Jones . **Mechanics Of Composite Materials.** . - R. M. Jones . 1999.
- R. M. Christensen . **Mechanics of Composite Materials**. Wiley.. 2005.
- E. Barbero. **Introduction to Composite Materials Design**. CRC Press, Taylor and Francis.. 2011.
- H. T. Hahn, S. W. Tsai . **Introduction to Composite Materials.** . Technomic Publishing AG.. 1980.
- P.K. Mallick . **Fiber-Reinforced Composites: Materials, Manufacturing, and Design**. CRC Press, Taylor and Francis.. 2008.
- K. K. Chawla . **Composite Materials: Science and Engineering**. Springer Science & Business Media,. 1998.

Complementary bibliography

- A. Miravete. **Materiales Compuestos. Vol. 1 y Vol. 2.** . INO Reproducciones. 2000.
- Suquet P. M. . **Elements of homogenization for inelastic solid mechanics. Homogenization Techniques for Composite Media**. Spring-Verlag. 1987.