ME-430

Mechanics of composites

Curtin William

Cursus	Sem.	Type
Mechanical engineering	MA1, MA3	Opt.

Language of teaching	English
Credits	5
Session	Winter
Semester	Fall
Exam	Written
Workload	150h
Weeks	14
Hours	**4 weekly**
Courses	3 weekly
Exercises	1 weekly
Number of positions	

Summary

Students will learn how to compute elastic, thermal, and other properties of composites as a function of materials and geometry; understand damage modes and strength limits for various classes of composites (polymers, metals, ceramics reinforced with particles or fibers).

Content

The course will consist of a systematic development of the mechanical models for predicting, or interpreting experimental results on, the mechanical properties of composites, including homogenized continuum response, damage mechanisms, strength/toughness, across the full spectrum of materials and geometries of current and future composite materials.

- Introduction on the scope of composite materials and applications
- Inclusions in a matrix: the Eshelby problem
- Multiple inclusions, effective material properties, and homogenization concepts
- Multiphase systems, anisotropic materials, plastic response, polycrystals and hierarchical systems
- Review of Fracture Mechanics concepts
- Damage Mechanisms in particulate composites
- Damage mechanisms in fiber-reinforced composites (polymer, metal, ceramic matrices)
- Long vs. short fiber composites and predictive strength models
- Mechanics of matrix cracking
- Polycrystalline ceramics as composites
- Damage-tolerant Design concepts
- Damage mechanics approaches to failure
- Biological and Nano composites

Keywords

Composites, Mechanical Behavior, Homogenization, Strength, Failure

Learning Prerequisites

Required courses

- Continuum mechanics
- Solid mechanics

Important concepts to start the course

- Apply the concepts of rigid and deformable body mechanics and of continuum mechanics to model and analytically solve problems of statics, structural stress analysis or simple mechanisms, S1
- Model with appropriate tools (analytical or numerical) the nonlinear (hyperelastic, plastic, buckling) and/or time-dependent (viscoelastic, viscoplastic) behaviour of structures and material under complex loadings, S12
- Basic programming skills in MATLAB or other high-level method

Learning Outcomes

By the end of the course, the student must be able to:

- Apply the principles of damage, fatigue and fracture mechanics to predict the size and localisation of critical defects and the number of cycles to failure of a real structure under complex loading conditions, S8
- Apply the models for the behaviour of composite materials and laminates to compute the stiffness, the deformed shape and the stresses of a simple composite structure. S7
- Present and evaluate the performance of different classes of composite materials and their constituents as well as the production processes currently in use, S6

Transversal skills

- Write a scientific or technical report.
- Continue to work through difficulties or initial failure to find optimal solutions.
- Make an oral presentation.

Teaching methods

Ex-cathedra

Assessment methods

Homework and mini-project assignments during the semester; final written exam

Supervision

Office hours	Yes
Assistants	Yes