Composite Materials: Analysis and Design
Course Syllabus
Spring 2009

Instructor

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Lecture

Monday / Wednesday / Friday: 8:30 – 9:20 am
Bell Engineering Building, Room 2273

Office Hours

Fayetteville: Monday / Wednesday / Friday: 9:30 to 10:30 am
Fort Smith: TBD

Text

Required:
Mechanics of Composite Materials, Second Edition, A.K. Kaw, 2005.
Supplementary:
Fiber-Reinforced Composites: Materials, Manufacturing and Design, P.K. Mallick, 1993.

Prerequisite

MEEG3013 – Mechanics of Materials

Statement of Course Objectives

The objectives of this course are to provide the student with (i) an introduction to composite materials and technology, (ii) a fundamental understanding of macro and micromechanical analysis of fibrous composite laminates, (iii) an overview of the use of composites in design, including their behavior under various loading conditions and (iv) exposure to the various manufacturing processes currently used to fabricate composite materials.

Course Outline

- Chapter 1: Introduction to composite materials
  - Lecture 1: Course overview and policies
  - Lecture 2: Definitions and classifications of different types of composites
  - Lecture 3: Overview of polymer matrix composites
  - Lecture 4: Advanced composite materials
  - Lecture 5: Review of mechanics of materials (Hooke's Law)
  - Lecture 6: Review of mechanics of materials (stress transformation, Mohr's circle)
  - Lecture 7: Review of mechanics of materials (failure theories)
  - Lecture 8: Review of matrix algebra and necessary mathematics

- Chapter 2: Macromechanical analysis of a lamina
  - Lecture 9: Material symmetries (3D monoclinic and orthotropic Hooke's Law)
  - Lecture 10: Materials symmetries (3D transversely isotropic Hooke's Law)
  - Lecture 11: Thin unidirectional lamina and derivation of engineering constants
  - Lecture 12: Examples and applications of unidirectional lamina
  - Lecture 13: Angle lamina introduction
  - Lecture 14: Derivation of engineering constants for angle lamina
  - Lecture 15: Examples and applications of angle lamina

- EXAM 1: Chapters 1 and 2

- Chapter 3: Micromechanical analysis of a lamina
  - Lecture 16: Introduction of micromechanics
  - Lecture 17: Fiber and matrix volume fractions
  - Lecture 18: Rule of mixtures derivation of longitudinal / transverse modulus
  - Lecture 19: Rule of mixtures derivation of Poisson's ratio and shear modulus
  - Lecture 20: Semi-empirical models (Halphin-Tsai equations)
  - Lecture 21: Method of elasticity to derive composite modulus
  - Lecture 22: Tensile strength of composite lamina as a function of volume fraction
  - Lecture 23: Compression and shear strengths of composite lamina

- EXAM 2: Chapter 3 (with necessary connections to Chapter 2)

- Chapter 4: Macromechanical analysis of a laminate
  - Lecture 24: Introduction to laminate design and code for laminate description
  - Lecture 25: Stresses and strains in laminates (force/moment relationships)
  - Lecture 26: Procedures for laminate analysis
  - Lecture 27: Laminate stress analysis example problems
  - Lecture 28: Special laminate geometries
  - Lecture 29: Examples and applications of special laminates

- Chapter 5: Design
  - Lecture 30: Failure of angle lamina (maximum stress/strain criterion)
  - Lecture 31: Failure of angle lamina (Tsai-Hill and Tsai-Wu criterion)
  - Lecture 32: Failure criterion for laminates
  - Lecture 33: Design considerations for composite laminates
  - Lecture 34: Design examples / carpet plots

- EXAM 3: Chapters 4 and 5

- Chapter 6: Manufacturing (notes from Mallick text – provided to student)
  - Lecture 35: Manufacturing fundamentals / curing and viscosity
  - Lecture 36: Manual fabrication techniques (contact, spray-up and bag molding)
  - Lecture 37: Medium-yield fabrication techniques (resin transfer molding)
  - Lecture 38: Large-yield fabrication techniques (pultrusion and compression molding)
  - Lecture 39: Rotational molding techniques (filament winding)
  - Lecture 40: Fabrication of advanced composites

Term paper

- A term paper will be required of all students
- The student is expected to research and review a specific topic or application that has significant relevance to composite materials
- The project may relate to the students individual area of interest or employment
- All term paper topics must be approved by Dr. Spearot prior to submission
- Examples of 'representative' project titles:
    - Fabrication of Kevlar based composite materials
    - Use of composite materials on the C130-Hercules transport aircraft
    - Fracture of fiber-reinforced composite panels

Grading

- Homework assignments (6 – 8 assignments): 25%
- Exams (3 total): 3 x 20% = 60%
- Term paper: 15%