Technical-Elective

Introduction to Mechanical Behavior of Fiber Reinforced Composites

Fall 2021

CATALOG DESCRIPTION

ME2033 (3 Cr.). Fiber reinforced composite materials with unidirectional and multi-layer settings. Fundamental concepts of fiber-reinforced composite materials of their manufacturing physical and mechanical properties, mechanical behavior, strength, design methodology.

Instructor: Gang Qi, PhD

Textbook: Mechanics of composite materials, by Robert M. Jones, 2nd Edition, CRC Press

Reference book: Analysis and performance of fiber composites, by B. D. Agarwal and L. J. Broutman, 3th Edition, Wiley (not required)

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Office hours 2:00-6:00 pm Weds.

Course Topics:

- Composite materials, advantages of composite materials
- Introduction to manufacturing process of composite materials,
- Mechanical behaviors of unidirectional lamina,
- Micromechanical behaviors of lamina,
- Micromechanical behaviors of a multilayer composites(laminate), and
- Responses of a laminate under various loadings.

Course project:

A one-week (tentative) course project will be given toward the end of the semester. The project is to evaluate students' ability to apply the knowledge to design a laminate plate.

Course outlines:

Part I

1. Introduction to composite materials
2. Brief review of mechanics of materials

Part II

1. Unidirectional composite materials
    1) Longitudinal behavior
       Initial stiffness, Load sharing
    2) Composite deformation/fracture behavior and mode
       Composites failure mechanisms, influencing factors
2. Transvers stiffness and strength

1) Constant stress model

   Stress equality, Displacement superposition,

2) Halpin-Tsai relations for Transverse modulus
3) Transverse strength
4) Prediction of shear modulus
5) Prediction of Poisson's ratio

Part III (chp 5 and 6 partial):

1. Stress-strain relationships and engineering constants
   1) Special orthotropic lamina
   2) General orthotropic lamina
   3) Engineering constant transformation
2. Hooke's Law, stiffness/compliance matrices
   4) General anisotropic materials
   5) Specially orthotropic material
   6) Transverse isotropic material
   7) Isotropic material, and
   8) Restrictions on elastic constants, transformation of stiffness/compliance matrices.
3. Strength of orthotropic lamina
   1) Maximum-stress theory
   2) Maximum-strain theory, and
   3) Maximum-work theory.
4. Analysis of laminated composites

   Laminate strains and stress, determination of laminate stresses and strains, analysis of laminates after initial failure.

Course project:

A one-week (tentative) course project will be given toward the end of the semester. The project will evaluate students' ability to apply the knowledge to design and optimize a laminate plate.

Grading*:

- Popup quiz 5%

- Homework/Class Assignments 10%
- Two midterm exams 40% (20% each)
- One-week course project 10%
- Final exam 35%

Numerical and letter scales conversion

Letter	A	A-	B+	B	B-	C+	C	C-	D+	D	F
Percentage (%)	100~90	89~85	84~80	79~76	75~73	72~70	69~66	65~63	62~61	60	<60