

# Composite Materials: Analysis and Design

(طراحی و تحلیل با مواد کامپوزیت الیافی-۲۰۱۳۵)

## Course Syllabus SPRING 2015

**INSTRUCTOR:** VahabToufigh, Ph.D., P.E.

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**LECTURE HOURS:** Sun, Tue: 10:30-11:45

**PREREQUISTES:** Engineering Mathematics

### **REFERENCES:**

- The International Handbook of FRP Composites in Civil Engineering, by M. Zoghi.
- Engineering Mechanics of Composite Materials, by Isaac M. Daniel.
- Introduction to Composite Materials, by Hull and Clyne,
- Introduction to Composite Materials Design, by Ever J. Barbero,
- Mechanics of Composite Materials, by R. Jone,
- Fiber-Reinforced Composites: Materials, Manufacturing and Design, by P.K. Mallick,

### **HOMEWORK:**

Accepted on A4 sheets using only one side. Homework must be presented in a neat, professional manner and it must be turned in at the beginning of the class period. Late homework is not acceptable without a valid cause.

**EXAMS:** There will be one midterm exam and a comprehensive final exam. Exam date TBA.

### **GRADING:**

- Exam I 30%
- Final Exam 35%
- Homework 15%
- Term Project 20%

### **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.

## **COURSE OUTLINE:**

- **Chapter 1: Introduction to Composite Materials**
  - Course overview and policies
  - Definitions and classifications of different types of composites
  - Overview of polymer matrix composites
  - Advanced composite materials
  - Application of FRP composites
  - Manufacturing of FRP composites
  - Mechanics terminology of composite structure
  
- **Chapter 2: Macromechanical Analysis of a Lamina**
  - Material symmetries (3D monoclinic and orthotropic)
  - Materials symmetries (3D transversely isotropic)
  - Thin unidirectional lamina and derivation of engineering constants
  - Examples and applications of unidirectional lamina
  - Angle lamina introduction
  - Derivation of engineering constants for angle lamina
  - Examples and applications of angle lamina
  
- **Chapter 3: Micromechanical Analysis of a Lamina**
  - Introduction of micromechanics
  - Fiber and matrix volume fractions
  - Rule of mixtures derivation of longitudinal / transverse modulus
  - Rule of mixtures derivation of Poisson's ratio and shear modulus
  - Semi-empirical models (Halpin-Tsai equations)
  - Method of elasticity to derive composite modulus
  - Tensile strength of composite lamina as a function of volume fraction
  - Compression and shear strengths of composite lamina
  
- **Chapter 4: Macromechanical Analysis of Laminates**
  - Introduction to laminate design and code for laminate description
  - Stresses and strains in laminates (force/moment relationships)
  - Procedures for laminate analysis
  - Laminate stress analysis example problems
  
- **Chapter 5: Failure, Analysis and Design of Laminates**
  - Special laminate geometries
  - Examples and applications of special laminates
  - Failure criterion for laminates
  - Design considerations for composite laminates
  - Design examples

**Any changes will be formally announced in class.**