

**Department of Materials Science and Engineering**  
**MSE 423 Materials Science and Engineering**  
**Fiber-Reinforced Composite Materials (4 credits)**

**Catalog Description:** Introduction to composites in polymer, metal or ceramic matrices. Properties of individual phases and of fiber/matrix interface; micromechanisms of load transfer from matrix to fiber; fabrication and elastic and failure properties. Laboratory studies of processing and properties of composites.

**Prerequisites:** Basic background in materials science and engineering, including

1. Mechanics of Materials (level of Engr. 220), and
2. Linear algebra and familiarity with matrix operations

**Textbook and Other Required Material**

1. Analysis and Performance of Fiber Composites by B. D. Agarwal and L. J. Broutman.
2. Supplemental reading material.

**Course Objectives:** Students will be able to

1. Define composites, their classification and know the advantages and disadvantages of different classes of composites.
2. Identify desirable materials for fibers, understand the processing of fibers and broad knowledge of their properties.
3. Evaluate the different choices of matrices and understand the effect of processing (e.g. extent of curing) on the properties of the thermoset matrices.
4. Evaluate the various processing techniques for composites and be able to design the composite microstructure for a specific set of properties.
5. Calculate the mechanical properties at the ply-level for a composite based on the properties of the constituents and geometrical considerations for both continuous and short fiber composites.
7. Conduct laboratory experiments on the processing and properties of composites together with data analysis, consideration for safety, working in teams and written presentations.
8. Students will be able to apply the knowledge gained in this course and other courses to conduct a paper design of a structure or component that should be made from using composites (material substitution)

**Topics Covered**

Lecture

Introduction: Definition of composites, why composites, why not composites, classes of composites, scope of course, input from students.

Fibers: Types of fibers, requirements and properties.

Matrices:	Polymeric, metallic and ceramic matrices, strategies in choosing matrices. Thermoset polymers.
Fiber/matrix interface:	Role of interface in controlling properties and coupling agents.
Properties:	Elastic properties, unidirectional lamina, short fiber composites, micromechanics of composites including elementary laminate theory, strength and fracture of composites, thermal and electrical properties of composites. (primary focus on polymer matrix composites).
Processing of Fibers:	Different types of common carbon, glass and organic fibers, new developments in fibers.
Processing:	Fiber architecture, detailed processing of polymer matrix composites (PMCs), preliminary introduction to the processing of metal matrix composites (MMCs) and ceramic matrix composites (CMCs).
Properties:	Overview of properties of ceramic and metal matrix composites

#### Laboratory Section

The laboratory section is intended to increase the student's understanding of the subject matter and be complementary to the lectures. It has the following components:

7. Hands-on experience with processing, structure and mechanical properties of composites (70%)
8. Field trips to local composite manufacturers and users (20%)
9. Presentations by engineers from industry on designing with composites (10%)

**Class Schedule:** Three, one hour lecture weekly; one three hour lab weekly.

#### **Contribution of the course to meeting the professional component**

This course provides student experience with both theory and experiments in composite materials development, manufacture and applications. It provides critical information to students who will work in the structural materials industries, and provides direct design experience to the students.

#### **Contribution of the course to program objectives**

This course applies advances science to develop the students' the understanding of structure/properties/processing/performance of composite materials. It includes experimental work, teamwork, communication and real-life applications, to assist the students in their careers.

**Prepared by:** Rajendra K. Bordia, Associate Professor, October 27, 2000