INTRODUCTION TO COMPOSITE MATERIALS
EML 4562
SPRING 2000

ROOM ENG 309 **(MWF 1:00 PM - 1:50 PM)**

INTRODUCTION: "*Do not give them any more straw to make bricks with, as your custom has been; let them go and find straw for themselves" (Exodus 5)*. Although man-made composites have existed for thousands of years, the high technology of advanced composites has been used in the aerospace industry only for the last thirty years. The applications are becoming diverse - from aircraft structures and missile canisters to tennis racquets and fishing rods. The objective of this course is to analyze and design structures made of fiber reinforced composite materials.

SHORT OBJECTIVES: Introduce to advanced composite materials and their applications. Develop fundamental relationships for predicting the mechanical and hygrothermal response of multi-layered materials and structures. Study micromechanical and macromechanical relationships for lamina and laminated materials with emphasis on continuous filament. Introduce material, structural and strength optimization to design laminated composite materials using user friendly software. For more information, visit these sites
http://www.eng.usf.edu/~kaw/class/composites, and
http://www.eng.usf.edu/~kaw/promal/book.html

OBJECTIVES (letters in brackets at end of each objective correspond to a-k program outcomes of Mechanical Engineering for ABET 2000 accreditation given below):

Introduction to Composite Materials (j)

Define a composite, enumerate advantages and drawbacks of composites over monolithic materials, and discuss factors which influence mechanical properties of a composite

Classify composites, introduce common types of fibers and matrices, and manufacturing, mechanical properties and applications of composites

Recycling of composites

Introduce terminology used for studying mechanics of composites

Micromechanics of a Lamina (a,e, l, n)

Review definitions of stress, strain, elastic moduli and strain energy

Develop stress-strain relationships for different types of materials

Develop stress-strain relationships for a unidirectional/bidirectional lamina

Find the engineering constants of a unidirectional/bidirectional lamina in terms of the stiffness and compliance parameters of the lamina

Develop stress-strain relationships, elastic moduli, strengths, thermal and moisture expansion coefficients of an angle ply based on those of a unidirectional/bidirectional lamina and the angle of the ply

Micromechanical Analysis of a Lamina (a, e, l, n)

Develop concepts of volume and weight fraction of fiber and matrix, density and void fraction in composites

Find the nine mechanical and four hygrothermal constants: four elastic moduli, five strength parameters, two coefficients of thermal expansion and two coefficients of moisture expansion of a unidirectional lamina from the individual properties of the fiber and the matrix, fiber volume fraction, and fiber packing

Discuss the experimental characterization of the above nine mechanical and four hygrothermal constants

Macromechanical Analysis of a Laminate (a, e, l, n)

Understand the code for laminate stacking sequence

Develop relationships of mechanical and hygrothermal loads applied to a laminate to strains and stresses in each lamina

Find the elastic stiffnesses of laminate based on the elastic moduli of individual laminas and the stacking sequence

Find the coefficients of thermal and moisture expansion of a laminate based on elastic moduli, coefficients of thermal and moisture expansion of individual laminas, and stacking sequence

Failure, Analysis and Design of Laminates (a, c, e, g, k, l, n, o)

Understand the significance of stiffness, and hygrothermal and mechanical response of special cases of laminates

Establish the failure criteria for laminates based on failure of individual lamina in a laminate

Design laminated structures such as plates, drive shafts and thin pressure vessels subjected to in-plane and hygrothermal loads

Introduce other mechanical design issues in laminated composites

PROGRAM OUTCOMES FOR MECHANICAL ENGINEERING

The measurable outcomes expected of all graduates of the program are stated below:

a. An ability to apply knowledge of mathematics, science and engineering;

b. An ability to design and conduct experiments, as well as to analyze and interpret data;

c. An ability to design a system, component or process to meet desired needs;

d. An ability to function on multi-disciplinary teams;

e. An ability to identify, formulate, and solve engineering problems;

f. An understanding of professional and ethical responsibility;

g. An ability to communicate effectively;

h. The broad educational necessary to understand the impact of engineering solutions in a global/societal

context;

i. A recognition of the need for and an ability to engage in life long leaming;

j. A knowledge of contemporary issues; and,

k. An ability; to use the techniques, skills, and modem engineering tools necessary for engineering practice;

1. A knowledge of chemistry and physics with depth in both.

m. An ability to apply advanced mathematics through multivariate calculus and differential equations.

n. A familiarity with statistics and linear algebra;

o. The ability to work professionally in both thermal and mechanical systems areas including the design and realization of such systems.

OUTCOMES:

Students would have fundamental knowledge in mechanical analysis and design of structures made of composite materials

PRE-REQUISITES: Machine Design and Analysis I, EML 3500 or equivalent and Computational Methods, EML 3041 or equivalent.

CALCULATOR: No programmable calculators are allowed in the classroom or tests. Calculators need to scientific with trignometric and other scientific functions. Statistical functions are allowed in the calculator. If you are unclear about the calculator, buy one and show it to me before opening the package. If the calculator costs more than $15, you are buying the wrong calculator.

TEXTBOOK: Mechanics of Composite Materials by Autar K. Kaw, CRC-LLC Press, FL, First Edition, 1997.

OFFICE LOCATION: ENG 118C

E-MAIL : kaw@eng.usf.edu

OFFICE HOURS: MWF 10-11 AM. Any other time by appointment 974-5626.

GRADING: Your final letter grade will be based on the following:

Test #1	Friday	February 4	15%
Test #2	Friday	March 3	15%
Test #3	Friday	April 7	15%
Test #4	Friday	April 28	15%
Homework		Due in class period after next	20%
Design Project	Wednesday	May 3: 10 AM	20% (Each day late: 25 points off)
TOTAL			**100%**

HOMEWORK: All problems in the book are assigned problems. However, in almost every class, at most two problems will be assigned which have to be submitted for grading in the next after next scheduled class period. Each problem counts as one homework assignment. No late HW will be accepted unless you have an excuse as given in the make-up test policy. You are responsible for knowing and submitting the assigned HW if you are absent from the class. The lowest grade in a HW in each chapter will be dropped.

GRADING POLICY:

Grade A - 90-100 Grade B - 80- 89 Grade C - 70- 79 Grade D - 60-69

Grade F - 0-59. Your final grade will be rounded off as follows at the end of the course. For example, 84.000001-85.000000 will be rounded off as 85, and 84-84.000000999999999 will be rounded off as 84.

COURSE SCHEDULE

TOPIC	**LECTURE HOURS**
CHAPTER 1	6
Introduction to Composite Materials	
CHAPTER 2	9
Macromechanical Behavior of a Lamina	
CHAPTER 3	9

Micromechanical Behavior of a Lamina	
CHAPTER 4	6
Macromechanical Behavior of a Laminate	
CHAPTER 5	8
Design and Failure of a Laminate	
TESTS	4

All the examinations and tests stated above will be closed book and closed notes. A formula sheet made by the instructor may be allowed to be used in an examination. Course grades will be evaluated on the above percentages and a letter grade will be assigned to you as outlined in the University catalog for undergraduates and graduates (1999-2000).

MAKE-UP TEST POLICY: In the event of a serious illness (physician's statement documenting severity of illness required), death in the family or other legitimate, documented, verifiable emergency resulting in the absence from a schedule test, a student may be given a make-up test. Notification of absence must be given prior to the commencement of the scheduled examination or test to me. Do not presume that your reasons for missing an examination or test are acceptable unless authorization is given to you.