MSE 4791: Mechanical Behavior of Composites

Credit hours and contact hours: 3-0-0-3

Instructor: Kyriaki Kalaitzidou

Textbook: P.K. Mallick, *Fiber-Reinforced Composites Materials, Manufacturing and Design*, Taylor Publishing, 3rd Edition, 2008.

Robert Jones, *Mechanics of Composite Materials*, Taylor Publishing, 2nd Edition, 1999.

Specific course information

Catalog description: Introduction to properties and structures of common matrix and reinforcing materials, mechanics of fiber-reinforced composites, lamina and laminate analysis, and mechanical performance.

Prerequisites: MSE 3005– Mechanical Behavior of Materials

Course: Selected Elective

Specific goals for the course

Outcomes of instruction:

1. The student will develop understanding of what a composite material is.
   1.1 The student will demonstrate a basic understanding of what a composite material consists of, how it behaves, suitable applications, and limitations.
   1.2 The student will demonstrate an understanding of how the structure and mechanical properties of the constituent materials affect the mechanical properties of the composite.
2. The student will gain a working knowledge on mechanical behavior of composite materials, mainly on fiber reinforced polymers.
   2.1 The student will demonstrate the ability to apply basic principles of mechanics.
   2.2 The student will demonstrate understanding of how to predict the mechanical response of a composite material under hygrothermal and mechanical loadings.
   2.3 The student will demonstrate an ability to select raw materials for a lamina, chose the proper stacking sequence of laminas and design a laminated composite structure using a software to best suit specific applications.
   2.4 The student will demonstrate the ability to find information, summarize, comment and critique studies on a specific topic related to mechanics of composites and the ability to write technical reports.

Student Outcomes:

(1) An ability to identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics.

(2) An ability to apply engineering design to produce solutions that meet specified needs with consideration for public health, safety, and welfare, as well as global, cultural, social, environmental, and economic factors.

(5) An ability to function effectively on a team whose members together provide leadership, create a collaborative and inclusive environment, establish goals, plan tasks, and meet objectives.

Topics covered:

1. Introduction to composites including advantages, disadvantages and applications
2. Materials: Fibers and fillers, surface treatment of fibers, fiber content, density, voids
3. Materials: Polymer matrix, metal matrix and ceramic matrix
4. Mechanics, including longitudinal and transverse tensile modulus, compressive strength and impact, of unidirectional lamina (continuous or discontinuous fibers)
5. Micromechanics
6. Characteristics of a fiber-reinforced lamina
7. Engineering constants for orthotropic materials, Plane Stress
8. Invariant properties, strengths of an orthotropic mamina
9. Laminated structure, Interlaminar stresses, Macromechanical behavior of a laminate,
10. Classical Lamination Theory
11. Performance: static, tension, compression, shear, flexure
12. Fatigue
13. Impact and other properties
14. Joining: pin bearing, adhesive bonding,
15. Design for long term properties
16. Conception and Design of laminated composite structures

Correlation between Outcomes of Instruction and Student Outcomes:

Outcomes of Instruction	Student Outcomes						
	1	**2**	**3**	**4**	**5**	**6**	**7**
1.1 The student will demonstrate a basic understanding of what a composite material consists of, how it behaves, suitable applications, and limitations.	X						
1.2 The student will demonstrate an understanding of how the structure and mechanical properties of the constituent materials affect the mechanical properties of the composite.	X						
2.1 The student will demonstrate the ability to apply basic principles of mechanics.	X						

2.2 The student will demonstrate understanding of how to predict the mechanical response of a composite material under hygrothermal and mechanical loadings.	X						
2.3 The student will demonstrate an ability to select raw materials for a lamina, chose the proper stacking sequence of laminas and design a laminated composite structure using a software to best suit specific applications.		X	X		X		
2.4 The student will demonstrate the ability to find information, summarize, comment and critique studies on a specific topic related to mechanics of composites and the ability to write technical reports.			X				X

School of Materials Science and Engineering Student Outcomes:

(1) An ability to identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics.
(2) An ability to apply engineering design to produce solutions that meet specified needs with consideration for public health, safety, and welfare, as well as global, cultural, social, environmental, and economic factors.
(3) An ability to communicate effectively with a range of audiences.
(4) An ability to recognize ethical and professional responsibilities in engineering situations and make informed judgments, which must consider the impact of engineering solutions in global, economic, environmental, and societal contexts.
(5) An ability to function effectively on a team whose members together provide leadership, create a collaborative and inclusive environment, establish goals, plan tasks, and meet objectives.
(6) An ability to develop and conduct appropriate experimentation, analyze and interpret data, and use engineering judgment to draw conclusions.
(7) An ability to acquire and apply new knowledge as needed, using appropriate learning strategies.