CEE 4170 (5170) Introduction to Mechanics of Composites

Elective Course

Catalog Description:
Lecture 3. Credit 3.
Prerequisite: CEE3110: Mechanics of Mechanics. Introduction to mechanics of fibrous, laminated composites. Micromechanics, mechanical properties, stiffness and strength, and classical laminate theory. Thermal and moisture effects. Effective engineering properties of laminates. Failure theories, design criteria, and computational implementation.

Math & Basic Sciences:	0 credits	
Engineering Topics:	3 credits	☐ Contains significant design
General Education:	0 credits	
Other:	0 credits	
Course Coordinator:	Y. Jane Liu	
Updated:	12/02/2021	

Text Book(s) and Supplemental Material(s):
The Behavior of Structures Composed of Composite materials,
Jack R. Vinson and Robert L. Sierakowski, 2nd Edition
Fiber-reinforced Composites, P. K. Mallick, 2nd Edition
Stress Analysis of Fiber-Reinforced Composite Materials, Michael W. Hyer, 2nd Edition
Mechanics of Composite materials, Robert M. Jones, 2nd Edition

Course Goal(s):
To introduce the student to the basic theories and applications of mechanics of reinforced laminated composite materials including classical laminate theory (CLT), 2-D ABD matrix, thermal and moisture effects, effective engineering properties, and failure theories for design. To provide a training to use Symbolic-Computational System MAPLE in composite structure analysis.

Instructional Outcomes for the Course:
Students will be expected to:
1. be able to derive 3-D constitutive equations for isotropic, transversely isotropic, and orthotropic materials and coordinate transformation.
2. be able to develop concepts related to fiber-reinforced composite materials at micor and macor mechanical level.
3. be able to understand how the stacking sequences effect mechanical properties of composite laminates.
4. be able to comprehend Classical Lamination Theory (CLT) with its basic assumptions, 2-D ABD matrix, mechanics behaviors of fibrous composites including moisture and temperature effects.
5. be able to understand failure theories for fiber-reinforced composites: first-ply failure and discount theory.
6. be able to learn fundamental analysis approaches to design of composite materials.
7. be able to use Symbolic-Computational System MAPLE in composite structure analysis.

Criterion 3 Student Outcomes addressed by this Course:

(3.1) an ability to identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics

Program Criteria addressed by this Course:

- apply knowledge of mathematics through differential equations, calculus-based physics, chemistry, and at least one additional area of basic science
- analyze and solve problems in at least four technical areas appropriate to civil engineering

Course Topics:

1. Review: math and mechanics of materials (5%)
2. 3-D stress and strain coordinate transformation (5%)
3. Constitutive equations for isotropic, transversely isotropic and orthotropic materials (15%)
4. The basic concept of fiber-reinforced composite materials: micromechanical models for effective engineering properties, fiber volume fraction (15%)
5. Fiber-matrix interactions in a unidirectional lamina, characteristics of a fiber-reinforced lamina, laminated structure, interlaminar stresses and strains (10%)
6. Classical Lamination Theory (CLT): basic assumptions, 2-D ABD matrix, mechanics behaviors of fibrous composites including moisture and temperature effects (20%)
7. Effective engineering properties of a laminate (10%)
8. Failure theories for fiber-reinforced composites: first-ply failure and discount theory (10%)
9. fundamental analysis approaches to design of composite materials (5%)
10. Maple package and Finite Element software (ANSYS) in composite structure analysis. (5%)

Additional Topics/Assignments for dual-level (4000/5000) courses:

Additional course project will be assigned to the graduate students registered for the CEE/ME5170. The topic for the project should be in the general area of the course. The results of the project will be presented in the form of an oral presentation or a poster.