D.19 SE 142: Design of Composite Structures

1. Catalog Description

Design and analysis of lightweight structures composed of laminated composite materials. Stiffness, strength, failure mechanisms, micromechanics, and hygrothermal behavior. Fabrication and experimental testing. Design projects that involve computer implementation

2. Prerequisites

SE 101C, SE 110 A, B, or permission of the instructor.

3. Textbook and Other Required Material

A.K. Kaw, Mechanics of Composite Materials, 2nd edition, CRC Press LLC,.

4. Course Objectives

Numbers in parentheses relate to the aerospace program's educational objectives

a. To provide an introduction to classes of fibers and resins, their performance attributes, and combination as polymer composites (1,2).
b. To provide a thorough understanding of the basic mechanics of laminated composite materials at both the micromechanics and macromechanics levels (1,2).
c. To provide students with expertise in composite analysis, including the use of special software (1,2)
d. To provide a complete design experience through a project involving materials selection, design, analysis, fabrication, testing, and reporting of results through written and oral formats (1-6)

5. Topics Covered

a. Constituent material types and properties
b. Processing methods and interactions
c. Micromechanics and materials design
d. Classical laminate theory and analysis
e. Application of CLT to design
f. Failure theories
g. Safety factors, determination, and responsibility
h. Design case studies

6. Class/Laboratory Schedule

Class: Mondays and Wednesdays i.e. a total of 3 hours of class-room instruction per week

Laboratory: Fridays, equivalent of one hour per group.

7. Method of Assessment and Evaluation

- Weekly homework assignments based on computer based analysis, design problems, and short descriptive answers for case selection (20%)
- Group project based on specific application designed to promote teamwork within an open-ended design environment building on the totality of the course. Includes both a written report and a an oral presentation by the group (10%)
- Laboratory exercises based on fabrication, testing and characterization of materials to be submitted as structured reports (10%)
- Mid-terms, including questions aimed at materials selection, design, and analysis (15% each)
- Final (30%)

8. Relationship of Course to Program Outcomes

The course is structured to provide a thorough understanding of composite materials as related to constituent types, micromechanics and classical lamination theory. The structure of the course requires students to begin to identify, formulate and solve problems through the correspondence of material performance attributes to application and design requirements (a,b,c, e). The use of specialized computer software is used to assist in investigating a variety of case studies (k). The laboratory exercises and project emphasize functioning in teams, whereas the assignments, project and reports build skills in written and verbal communication (d,g). The aspects of professional responsibility and ethics are emphasized through discussions, exercises and case studies relating to real world applications and the implications of use of polymer composites in aerospace, automotive, marine and civil infrastructure applications (h,i,j).

9. Contribution of Course to Meeting the Professional Component

The course provides both specialization and a design component while simultaneously exposing students to a multidisciplinary environment and the impact of engineering choices on design. It provides structural engineers with expertise in state-of-the-art technology and the means to apply to aerospace, civil, mechanical and naval/offshore structures.

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Revised: Vistasp M. Karbhari, 2/16/2001