# Department of Materials Science and Engineering University of Maryland, College Park

ENMA 421/621: Design of Composite Materials – Spring 2020

**Course Description:** This course covers fundamentals of design, processing and selection of composite materials for structural applications. The topics include a review of all classes of engineering materials, an in-depth analysis of micro and macro mechanical behavior including interactions at the two-phase interfaces, modeling of composite morphologies for optimal microstructures, material aspects, cost considerations, processing methods including consideration of chemical reactions and stability of the interfaces and material selection considerations.

**Instructor:** Prof. S. Ankem

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**Prerequisites:** Permission of the department.

**Text Book:** “Composite Materials: Science and Engineering” 3rd Edition by K. Chawla, Springer Science, 2012. ISBN: 978-0-387-74364-6

## Reference Books/Papers:

1. “Material Selection in Mechanical Design” by M.F. Ashby, Pergamon Press, 1992.
2. “Composites Materials: Engineering and Science” by F.L. Matthews and R.D. Rawlings, CRC Woodhead Publishing Limited, 2002.
3. “Mechanical Properties of Alloys Consisting of Two Ductile Phases” by S. Ankem, H. Margolin, C.A. Greene, B.W. Neuberger, and P.G. Oberson, *Progress in Materials Science*, 2006, available online.

In addition, several journal articles will be used, and will be posted on the ELMS as needed.

**Course Objective:** The main objective of this course is to teach fundamentals of composite materials as related to design, processing and selection for structural applications. Satisfactory completion of the course should demonstrate the ability to:

1. Understand the basic principles of composites materials.
2. Learn about various types of composites including processing.
3. Predict composite behavior from the knowledge of component phases properties and
4. Design and select composites for a given structural application.

## Topic Covered

1. INTRODUCTION: REVIEW OF VARIOUS CLASSES OF ENGINEERING MATERIALS INCLUDING

Metals, Ceramics, Glasses, Polymers, Elastomers and Composites.

1. A REVIEW OF MECHANICAL PROPERTIES

Strength, Hardness, Fatigue, Toughness, Damping capacity, Creep, Thermal shock resistance, Wear, Corrosion.

1. OVERVIEW OF COMPOSITES AND TYPES OF REINFORCEMENTS
2. MICROMECHANICS, MACROMECHANICS AND FINITE ELEMENT MODELING
3. MATRICES AND THE REINFORCEMENT-MATRIX INTERFACE
4. TYPES OF COMPOSITES Metal Matrix Composites Ceramic Matrix Composites Polymer Matrix Composites
5. MONOTONIC STRENGTH AND FRACTURE
6. FATIGUE
7. LOW AND HIGH TEMPERATURE CREEP
8. DESIGN WITH COMPOSITES

**Class Schedule:** Monday and Wednesday, 3:30-4:45 PM, Room CHE 2136

## Grading:

Unannounced Quizzes: 15%

Homework Assignments: 15%

Preliminary Presentation about Design Project/Term Paper

(March 4, 2020 in class): 5%

Midterm-1 Exam (March 11, 2020 in class): 20% Midterm-2 Exam (April 27, 2020 in class): 20%, CANCELLED, Individual Average Score of the Remaining 80 points will be assigned to this Exam

Design Project/Term Paper Presentation (April 29, May 4, 6, and 11, 2020):12.5% Final Report on the Design Project/Term Paper should be submitted on or before the Final Exam date (May 16, 2020): 12.5%

**Notes**: 1. Design project will be different for ENMA 421 as compared to ENMA 621, which will be discussed in the class.

2. The Presentation and submission of a final report on Design Project/Term Paper constitute the Final Exam.

**Class Policy:** Quizzes can be given on any lecture day at any time during the class. Students are required to make every reasonable effort to inform the instructor by email before the start of class if they will be absent, and must explain the reason for the absence. If a grading event (exam, presentation, unannounced quiz) occurs on the day of absence, the student must submit a self-signed letter explaining the reason for their absence. The letter from the student is subject to the rules of the Student Honor Code of the University of Maryland. If the instructor does not receive this letter promptly following the absence, the student will be given zero credit for the grading event missed.

If a student is absent more than one time during the semester, the student must submit documentation signed by a health care professional justifying the absence.

Make-up of any grading event is subject to the discretion and convenience of the instructor.