

# ME 446/646 Introduction to Composite Materials

## Syllabus

Instructor:

Contact Information:

Time/Location:

### Required Text

"Fiber-Reinforced Composites: Materials, Manufacturing, & Design", Third Edition, P.K. Mallick, Marcel Dekker, 2007

### Course Objectives

The overall goal of this course is to learn the important aspects of fiber reinforced materials and be able to answer the following questions:

- What materials are primarily used to make composite materials?
- How are the materials and structures manufactured?
- How do you determine the material properties for failure analysis and deformation prediction?
- How do you design composite structures to optimize structural performance?
- What are some contemporary issues being addressed by the composites technical community?

### Course Outline

Dates	Chap	Topics / Lectures	Homework Due Dates
1/17		(L01) Introduction, Course Outline	
1/22 1/24	1 2	(L02) General Characteristics, (L03) Fiber Properties	
1/29 1/31	2 2	(L04) Matrix Properties (L05) Micromechanics, Project Proposals	<b>HW Ch 1: 1, 3, 6, 7, 8, 9</b> Project Proposals Due (Feb 2)
2/5 2/7	3 3	(L06) Longitudinal Strength, Short fibers HW questions	<b>HW Ch 2: 2, 4, 10, 11, 13, 20</b>
2/12 2/14	3 3	(L07) Transverse and other lamina props (L08) Lamina Analysis, HW Questions	<b>HW Ch 3a: 2, 5, 8, 9</b>
2/19 2/21	3 3	<b>President's Day (No Class)</b> (L09) Laminate Analysis	<b>HW Ch 3b: 20, 24, 27</b>
2/26 2/28	3 3	(L10) Laminate Analysis Examples (L11) Laminate Analysis Examples	
3/5 3/7	4 4	(L12) Static Mechanical Properties, Fatigue (L13) Fatigue, Creep & Other Properties	<b>HW Ch 3c: 32, 38, 42, 47, 50</b>
3/12 3/14		<b>Exam 1a In-class (chapters 1 – 3)</b> <b>No Class Exam 1b Take-home (chapters 1 – 3)</b>	
3/19 3/21	4 4	(L14) Fracture & Damage Tolerance Characterization Lab Demos	
3/26 3/28		<b>Spring Break</b>	
4/2 4/4	5 5	(L15) Manufacturing Issues Mechanical (L16) Thermoplastics, Inspection Methods	<b>HW Ch 4: 1, 5, 6, 7, 11, 22, 24, 35</b>
4/9		<b>No Class</b>	

Dates	Chap	Topics / Lectures	Homework Due Dates
4/11	5	Manufacturing Exam and Homework 5 hints	
4/16	5	Manufacturing Lab Guest Lecture – Dr/ Boyd	
4/18	6	(L17) Lamina Failure Theories	
4/23	6	(L18) Laminate Failure and Design Considerations	<b>HW Ch 5:</b> 2, 5, 9, 10, 14, 15, 19
4/25	6	<b>No Class</b>	
4/30		Project Presentations (5-10 minutes)	<b>HW Ch 6:</b> 1, 3, 6, 15(a & d), 22
5/2		Project Presentations (5-10 minutes)	<b>Project Reports Due</b>
5/7		<b>Exam 2 (chapters 4 – 6) 1:00 – 3:00 PM</b>	

## Office Hours:

TBD

## Homework:

The homework assignments are due at the beginning of class on the dates specified on the previous page. The problems and due dates may be changed during the semester. Any changes will be announced in class and through the WebCampus Announcement system; it is your responsibility to be aware of these changes.

## Exams:

In-class exams will be closed book format with a mixture of short concept based questions and longer mathematical problem solving questions. Students are normally allowed to bring one page (8.5” x 11”, front and back) of reference notes. Details about the reference sheet will be provided prior to the exam. The second exam usually has an in-class and take-home section.

## ME 446 GRADING:

- Exam 1: 25 %
- Homework Assignments: 25 %
- Design Project: 25 %
- Exam 2: 25 %

## ME 646 GRADING:

- Exam 1: 20 %
- Homework Assignments: 15 %
- Research Project Proposal: 10 %
- Exam 2: 25 %
- Research Project Report: 15 %
- Research Project Presentation: 15 %

## Design/Research Project Schedule and Format

### Week 2

Project proposal discussion time in class

Students can choose any design or research topic related to composite materials. These can be done in groups of 1-3 students. The project should include a significant literature review of the topic that includes at least 10 different sources per student in the group. Examples could be the design of a specific structural

component, research of a new manufacturing method, performance characteristics of a new material system, or any related topic. Some details of report are shown below.

#### **Week 4**

Project proposals due

Submit by email to instructor.

#### **Week 14**

Presentations due (scheduled in class this week)

#### **Week 15**

Submit complete design report

### **Academic Dishonesty Policy**

Cheating on exams or homework will result in a failing grade for the class. Plagiarism on reports will result in a failing grade for the class.

### **Project Requirements and Outline**

1. Group names, project title, subtasks  
You must have a minimum of 1 person per group and a maximum of 3. Each person should be responsible for a specific part of the project/report.
2. Concise statement of the problem that clearly defines what you are trying to accomplish
  - a) Structural analysis and design of a composite component
  - b) How would the component be made
  - c) Literature review of a contemporary composites research topic
3. What are the design constraints?
  - a) Geometric limitations, weight limitations, etc., loading conditions
4. What are the design criteria? (How will you compare different design options?)
  - a) strength, cost, stiffness, etc
5. Analysis / Fabrication / Review of literature  
Material options, manufacturing options (prototype vs. production), recommended testing, test results (if possible), stress analysis, assumptions made for stress analysis, software used, assumptions used about loading conditions, confidence level in your assumptions and analysis, error estimates, etc.
6. Summary and recommendations
7. Well formatted list of references (examples below)  
All references should be cited in the body of the text. There should be a minimum of 10 references per group member for any type of project. A research literature review project should have a minimum of 10 journal publication references per group member.

### **Example Format for Report**

**(This is an example only. You may have different sections and subsections)**

1. Title Page
  - A. Title of project
  - B. Authors
  - C. Contact information (email)
  - D. Date submitted
2. Abstract

- A. Objective
  - B. Brief summary of procedure
  - C. Summary of results
3. Introduction
- A. Literature survey
  - B. Detailed description of the problem
  - C. Discuss design procedure, options, selection criteria
4. Analysis Methodology
- A. Discuss methods and assumptions used
  - B. Include sketch's and free body diagrams
  - C. Use text to describe your equations
  - D. Include description of experiments (if appropriate)
5. Results
- A. Include tables or graphs based on your analysis
  - B. Discuss results shown in tables or graphs
  - C. Select final design
6. Conclusions
- A. Discuss the significance of your results
  - B. Did you meet your objectives?
  - C. How could you improve the design or the analysis
7. References
8. Appendices
- A. Sample Calculations
  - B. Raw Data

## **Preferred Citation Format for References**

The references are listed in the order that they are cited in the text of the report. Cite references in the text using a number in brackets, [12]. Include the numbers in the list of references.

### **Example body text:**

... The bicycle frame that was fabricated for this class only weighed 3 pounds, which was lighter than any other on record that could be found [8].

### **Corresponding list of references:**

- [1] O'Brien, K., Crincoli, J. F. and Kauffman, R. L. "Long Strand, Fiber-Reinforced, Thermoplastic Engineering Resins for Unique Combinations of Stiffness, Toughness and Injection Moldability", Proceedings of the 43rd Annual Conference, Composites Institute, February 1-5, 1988.
- [2] Hauser, R. L. and Mund, H. "How to Strengthen and Stiffen Composite Panels", Proceedings of the 36th Annual Conference, Reinforced Plastics/Composites Institute, February 16-20, 1981.
- [3] Levin, S. C. "Composites and Bicycles: Market Diversification in Action", Proceedings of the 38th International SAMPE Symposium, May 10-13, 1993.
- [4] Weingart, O. "Winding for the Wind", Proceedings of the 36th Annual Conference, Reinforced Plastics/Composites Institute, February 16-20, 1981.
- [5] Hart-Smith, L. J. "How to Calculate In-Plane Strengths of Fiber-Polymer Composite Laminates", SAMPE Journal, Vol. 28, No. 6, 1992, pp 25-35.
- [6] Hopkins, M. W., Principe, F. S., and Kelleher, K. J. "Beyond Materials: DuPonts Aerodynamic

- Bicycle Wheel", Proceedings of the 35th International SAMPE Symposium, April 2-5, 1990.
- [7] Howarth, C. S, Balonis, R. and Ko, F. K. "The Design and Manufacture of Composite Intensive Vehicles", Proceedings of the 35th International SAMPE Symposium, April 2-5, 1990.
- [8] Kubomura, K., et al. "The Lightest Composite Monocoque Bicycle Frame", Proceedings of the 35th International SAMPE Symposium, April 2-5, 1990.
- [9] Lane, D. M., et al. "Comparison of Processing Techniques for the Molding of Hollow Advanced Composite Parts", Proceedings of the 38th International SAMPE Symposium, May 10-13, 1993.
- [10] Poveromo, L. M. and Suarez, J. A. "Fabrication and Test of Integrally Stiffened Graphite/Epoxy Components", Proceedings of the 36th Annual Conference, Reinforced Plastics/Composites Institute, February 16-20, 1981.

## University Policies

### Public Health Directives

Face coverings are mandatory for all faculty and students in the classroom. Students must follow all active UNLV public health directives while enrolled in this class. [UNLV public health directives](https://www.unlv.edu/coronavirus/health-requirements) are found at <https://www.unlv.edu/coronavirus/health-requirements>. Students who do not comply with these directives may be asked to leave the classroom. Refusal to follow the guidelines may result in further disciplinary action according to the [UNLV Student Conduct Code](https://www.unlv.edu/sites/default/files/page_files/27/StudentConduct-Code.pdf), [https://www.unlv.edu/sites/default/files/page\\_files/27/StudentConduct-Code.pdf](https://www.unlv.edu/sites/default/files/page_files/27/StudentConduct-Code.pdf), including being administratively withdrawn from the course.

### Academic Misconduct

Academic integrity is a legitimate concern for every member of the University community. We all share in upholding the fundamental values of honesty, trust, respect, fairness, responsibility, and professionalism. By choosing to join the UNLV community, students accept the expectations of the Student Academic Misconduct Policy, and are encouraged to always take the ethical path whenever faced with choices. Students enrolling at UNLV assume the obligation to conduct themselves in a manner compatible with UNLV's educational mission. An example of academic misconduct is plagiarism. Plagiarism is using the words or ideas of another person, from the Internet or any other source without proper citation of the source(s). See the [Student Conduct Code](#).

### Auditing Classes

Auditing a course allows a student to continue attending the lectures and/or laboratories and discussion sessions associated with the course, but the student will not earn a grade for any component of the course. Students who audit a course receive the same educational experience as students taking the course for a grade, but will be excused from exams, assessments, and other evaluative measures that serve the primary purpose of assigning a grade.

### Classroom Conduct

Students have a responsibility to conduct themselves in class and in the libraries in ways that do not interfere with the rights of other students to learn, or of instructors to teach. Use of devices such as pagers and cellular phones, or potentially disruptive activities are only permitted with the prior explicit consent of the instructor. Students are specifically prohibited to record classes without instructor authorization, including online/remote classes (either audio only, or video and audio). The instructor may rescind permission at any time during the class. If a student does not comply with established

requirements or obstructs the functioning of the class, the instructor may initiate an administrative withdrawal of the student from the course.

Since the COVID-19 pandemic forced most instruction to be delivered remotely starting on March 2020, numerous students have asked instructors to record their synchronous classes, so that they can access them at their convenience. Instructors who agree to record their classes (audio only, or video and audio) should inform students in advance. Recorded lectures may not be broadly released to anyone, but made available exclusively to those students enrolled in the class during the particular academic term. Recorded lectures must be stored securely, and are subject to the Nevada System of Higher Education's Records Retention Policy, meaning that the recordings can only be deleted 120 days after the end of class (i.e., after grades are posted). Once this requirement is met, the recordings should be deleted. Class recordings are protected from disclosure, as they are deemed part of an educational record under the Family Educational Rights and Privacy Act (FERPA).

## **Copyright**

The University requires all members of the University Community to familiarize themselves with, and to follow copyright and fair use requirements. You are individually and solely responsible for violations of copyright and fair use laws. The University will neither protect nor defend you, nor assume any responsibility for employee or student violations of fair use laws. Violations of copyright laws could subject you to federal and state civil penalties and criminal liability, as well as disciplinary action under University policies. Additional [copyright policy information](https://www.unlv.edu/provost/copyright) is available at <https://www.unlv.edu/provost/copyright>.

## **Disability Resource Center (DRC)**

The [UNLV Disability Resource Center](https://www.unlv.edu/drc) (Student Services Complex, SSC-A, Room 143, <https://www.unlv.edu/drc>, telephone 702-895-0866) provides resources for students with disabilities. Students who believe that they may need academic accommodations due to a permanent disability, temporary or permanent medical need, or academic support due to pregnancy are encouraged to contact the DRC as early as possible in the academic term. A Disabilities Specialist will discuss what options may be available to you. Students who are already registered with the DRC should request their accommodations online each semester, and make an appointment to discuss their accommodations with their instructors.

## **Final Examinations**

The University requires that final exams given at the end of a course occur on the date and at the time specified in the Final Exam schedule. The Final Exam schedule is typically available at the start of the semester, and the classroom locations are available approximately one month before the end of the semester. See the [Final Exam Schedule](#).

## **Identity Verification in Online Courses**

All UNLV students must use their Campus-issued ACE ID and password to log in to WebCampus-Canvas.

UNLV students enrolled in online or hybrid courses are expected to read and adhere to the [Student Academic Misconduct Policy](https://www.unlv.edu/studentconduct/misconduct/policy), <https://www.unlv.edu/studentconduct/misconduct/policy>, which states that “acting or attempting to act as a substitute for another, or using or attempting to use a substitute, in any academic evaluation or assignment” is a form of academic misconduct. Intentionally sharing ACE

login credentials with another person may be considered an attempt to use a substitute, and could result in investigation and sanctions, as outlined in the Student Academic Misconduct Policy.

UNLV students enrolled in online courses are also expected to read and adhere to the [Acceptable Use of Computing and Information Technology Resources Policy](#),

<https://www.it.unlv.edu/policies/acceptable-use-computing-and-information-technology-resources-policy>, which prohibits sharing university accounts with other persons without authorization.

To the greatest extent possible, all graded assignments and assessments in UNLV online courses should be hosted in WebCampus-Canvas or another UNLV-managed platform that requires ACE login credentials for access.

## **Incomplete Grades**

The grade of “I” (Incomplete) may be granted when a student has satisfactorily completed three-fourths of course work for that semester/session, but cannot complete the last part of the course for reason(s) beyond the student’s control and acceptable to the instructor, and the instructor believes that the student can finish the course without repeating it. For undergraduate courses, the incomplete work must be made up before the end of the following regular semester. Graduate students receiving “I” grades in 500-, 600-, or 700-level courses have up to one calendar year to complete the work, at the discretion of the instructor. If course requirements are not completed within the period indicated, a grade of “F” will be recorded, and the student’s GPA will be adjusted accordingly. Students who are fulfilling an Incomplete grade do not register for the course, but make individual arrangements with the instructor who assigned the “I” grade.

## **Library Resources**

Librarians are available to consult with students on research needs, including developing research topics, finding information, and evaluating sources. To make an appointment with a subject expert for this class, please visit the [Libraries’ Research Consultation](#) website, <https://guides.library.unlv.edu/appointments/librarian>. You can also [ask the library staff](#) questions via chat and text message at <https://ask.library.unlv.edu/>.

## **Missed Classwork**

Any student missing class, quizzes, examinations, or any other class or laboratory work because of observance of religious holidays will be given an opportunity during that semester to make up the missed work. The make-up opportunity will apply to the religious holiday absence only. It is the responsibility of the student to notify the instructor within the first 14 calendar days of the course for Fall and Spring courses (except for modular courses), or within the first 7 calendar days of the course for Summer and modular courses, of their intention to participate in religious holidays which do not fall on state holidays or periods of class recess. For additional information, please visit the Missed Classwork policy, under Registration Policies, on the [Academic Policies](#).

In accordance with the policy approved by the Faculty Senate regarding missed class time and assignments, students who represent UNLV in any official extracurricular activity will also have the opportunity to make up assignments, provided that the student provides official written notification to the instructor no less than one week prior to the missed class(es).

The spirit and intent of the policy for missed classwork is to offer fair and equitable assessment opportunities to all students, including those representing the University in extracurricular activities. Instructors should consider, for example, that in courses which offer a “Drop one” option for the



lowest assignment, quiz, or exam, assigning the student a grade of zero for an excused absence for extracurricular activity is both contrary to the intent of the Faculty Senate's policy, and an infringement on the student's right to complete all work for the course.

This policy will not apply in the event that completing the assignment or administering the examination at an alternate time would impose an undue hardship on the instructor or the University that could be reasonably avoided. There should be a good faith effort by both the instructor and the student to agree to a reasonable resolution. When disagreements regarding this policy arise, decisions can be appealed to the Department Chair/School Director, College/School Dean, and/or the Faculty Senate Academic Standards Committee.

For purposes of definition, extracurricular activities may include, but are not limited to: academic recruitment activities, competitive intercollegiate athletics, fine arts activities, liberal arts competitions, science and engineering competitions, and any other event or activity sanctioned by a College/School Dean, and/or by the Executive Vice President and Provost.

## **Rebelmail**

Rebelmail is UNLV's official email system for students and by University policy, instructors and staff should only send emails to students' Rebelmail accounts. Rebelmail is one of the primary ways in which students receive official University communications, information about deadlines, major Campus events, and announcements. All UNLV students receive a Rebelmail account after they have been admitted to the University. Emailing within WebCampus-Canvas is also acceptable.

## **Tutoring and Coaching**

The Academic Success Center (ASC) provides tutoring, academic success coaching, and other academic assistance for all UNLV undergraduate students. For information regarding tutoring subjects, tutoring times, and other ASC programs and services, please visit the [ASC website](https://www.unlv.edu/asc), <https://www.unlv.edu/asc>, or call 702-895-3177. The ASC building is located across from the Student Services Complex (SSC). Academic success coaching is located on the second floor of SSC A, Room 254. Drop-in tutoring is located on the second floor of the Lied Library, and on the second floor of the College of Engineering building (TBE A 207).

## **UNLV Writing Center**

One-on-one or small group assistance with writing is available free of charge to UNLV students at the [Writing Center](https://writingcenter.unlv.edu/), <https://writingcenter.unlv.edu/>, located in the Central Desert Complex, Building 3, Room 301 (CDC 3-301). Walk-in consultations are sometimes available, but students with appointments receive priority assistance. Students may make appointments in person or by calling the Center, telephone 702-895-3908. Students are requested to bring to their appointments their Rebel ID Card, a copy of the instructions for their assignment, and two copies of any writing they have completed on their assignment.

## **Diversity Statement**

As an institution of higher learning, UNLV represents a rich diversity of human beings among its faculty, staff, and students, and is committed to aspiring to maintain a Campus environment that values that diversity. Accordingly, the University supports understanding and appreciation of all members of its community, regardless of race, sex, age, color, national origin, ethnicity, creed, religion, disability, sexual orientation, gender, gender identity, marital status, pregnancy, genetic information, veteran



status, or political affiliation. Please see [University Statements and Compliance](https://www.unlv.edu/about/statements-compliance), <https://www.unlv.edu/about/statements-compliance>.

A successful learning experience requires mutual respect and trust between the students and the instructor. Accordingly, the instructor asks that students be willing to listen to one another's points of view, acknowledging that there may be disagreements, keep discussion and comments on topic, and use first person, positive language when expressing their perspectives.