MEC 456/556 - Introduction to Engineering Mechanics of Composites

Fall Semester 2019

Credits: 3 credits

Prerequisite: MEC 363 or equivalent course (working knowledge of linear matrix algebra and also basic coding skills in MATLAB)

Lectures: Mondays 4:00 – 6:50PM at Humanities Room 3017

Instructor: Kedar Kirane (kedar.kirane@stonybrook.edu)

Office Hours: Tue, Thu 1:30 – 3:00PM in Light Engineering 133

Primary Text Book:

- *Engineering Mechanics of Composite Materials*, Isaac M. Daniel & Ori Ishai. Oxford Press (2006, second edition) ISBN 978-0-19-515097-1

Other Suggested Reference Books:

- *Autar K. Kaw, "Mechanics of Composite Materials," 2nd ed., Taylor and Francis*
- *Robert M. Jones, "Mechanics of Composite Materials," Taylor and Francis.*

Grading:

Semester letter grade will be decided based on your relative ranking in the class. An average score will be considered equivalent to a B.

Your aggregate score to determine your location in the curve is based on the following categories:

Homework (about every 2 weeks)	40%
Mid-Term Exam (mid-late October)	30%
Final Exam (TBD)	30%

A group project will also be assigned towards the end of the semester which will involve reviewing a published research article and making a class presentation. (the grade for the project will be counted under homework)

Course Description:

Introduction to the engineering mechanics of fiber reinforced composites. Brief history of the development of fiber composites, their properties, advantages, limitations and applications.

Overview of the different types of composites but with focus on long fiber reinforced composites; particularly, lamina and laminate concepts characteristics and configurations. The course introduces various length-scales at which composites are analyzed (individual fibers/matrix, lamina and laminates).

Topics covered include: elastic properties of unidirectional lamina, strength (and progressive failure) of unidirectional lamina, elastic behavior of multidirectional laminates and strength and progressive failure of multidirectional laminates. Design methodologies and considerations for structural composite materials.

The course also introduces the students to various modes of failure in composites, various lamina failure theories, classical laminate theory, and briefly fracture mechanics.

Details of topics covered:

- *Introduction* - Relevant terminology, advantages & disadvantages of composites, role of constituents (fibers, matrix), synthesis and fabrication techniques, types of composites, degrees of anisotropy
- *UD lamina* – Elastic constitutive relations, relations between mathematical and elastic constants, plane stress constitutive relation, transformation of elastic parameters, effective elastic properties (fiber volume ratio, rule of mixtures)
- *Strength of UD lamina* – Failure mechanisms and failure criterion, failure theories (stress, strain, Tsai Hill, Tsai Wu)
- *Multi-directional laminates* – Macro-mechanical Analysis, Elastic properties, Laminate theory, *(*Cross-Ply, Moment-Curvature, Basic), Stress and Failure analysis
- *Failure and Design of Laminates* - Ply Arrangements, Failure Theories, Failure Criterion
- *Other topics:* Fatigue, Fracture mechanics, Quasi-brittleness, Size Effects, Mechanical testing methods overview, Hygro-thermal effects

Course Learning Objectives (CLOs):

1. Become familiar with the advantages and limitation of fiber composites in comparison with conventional structural materials
2. Be able to use stress-strain linear elastic constitutive relations in structural analysis, including isotropic, anisotropic, orthotropic and transverse isotropic relations
3. Understand coordinate transformation of stress, strain, stiffness and compliance matrices
4. Understand various theoretical methods for predicting effective elastic properties and their relative advantages and limitations
5. Be able to determine the onset of failure in composites using various strength-based failure theories
6. Be able to determine the elastic behavior of multidirectional laminates composed of plies with different orientations
7. Be able to appreciate the shortcomings of strength-based failure theories, and importance of fracture mechanics

CLO Assessment tool for all above CLOs will be homework and exams

STUDENT ACCESSIBILITY SUPPORT CENTER (SASC) STATEMENT:

If you have a physical, psychological, medical or learning disability that may impact your course work, please contact the Student Accessibility Support Center (SASC), ECC (Educational Communications Center) Building, room 128, (631) 632-6748. They will determine with you what accommodations, if any, are necessary and appropriate. All information and documentation is confidential. Students who require assistance during emergency evacuation are encouraged to discuss their needs with their professors and the staff at the Student Accessibility Support Center (SASC). For procedures and information go to the following website: http://www.stonybrook.edu/ehs/fire/disabilities]

ACADEMIC INTEGRITY STATEMENT:

Each student must pursue his or her academic goals honestly and be personally accountable for all submitted work. Representing another person's work as your own is always wrong. Faculty are required to report any suspected instances of academic dishonesty to the Academic Judiciary. Faculty in the Health Sciences Center (School of Health Technology & Management, Nursing, Social Welfare, Dental Medicine) and School of Medicine are required to follow their school-specific procedures. For more comprehensive information on academic integrity, including categories of academic dishonesty, please refer to the academic judiciary website at http://www.stonybrook.edu/commcms/academic_integrity/index.html

CRITICAL INCIDENT MANAGEMENT STATEMENT:

Stony Brook University expects students to respect the rights, privileges, and property of other people. Faculty are required to report to the Office of Judicial Affairs any disruptive behavior that interrupts their ability to teach, compromises the safety of the learning environment, or inhibits students' ability to learn. Faculty in the HSC Schools and the School of Medicine are required to follow their school-specific procedures.

CALCULATOR POLICY

Only the following calculators will be permitted to be used on all midterm and final exams in the Department of Mechanical Engineering. There will be no exceptions! This list of calculators is identical to that allowed for the National Council for Examiners for Engineering and Surveying (NCEES) Fundamentals of Engineering (FE) exam that many of you will take in your senior year, as well as Professional Engineering (PE exam) that you may take.

Casio:	All fx-115 models. Any Casio calculator must contain fx-115 in its model name.
Hewlett Packard:	The HP 33s and HP 35s models, but no others.
Texas Instruments:	All TI-30X and TI-36X models. Any Texas Instruments calculator must contain either TI-30X or TI-36X in its model name.

For detail information, follow https://ncees.org/exams/calculator-policy/

MAKE UP EXAMS:

Make-up exams must be arranged prior to the exams. The class policy on make-up exams is consistent with university policy on Student Participation in University Sponsored Events, the policy on Final Exams and the New York State Education Law regarding Equivalent Opportunity and Religious Absences.