

## MEC 641 FRACTURE MECHANICS - Fall 2020

**Prerequisite:** MEC 536

**Lectures:** Wednesday 2:40 – 5:30 PM at Humanities 3017

**Instructor:** Toshio Nakamura ([toshio.nakamura@stonybrook.edu](mailto:toshio.nakamura@stonybrook.edu))  
Kedar Kirane ([kedar.kirane@stonybook.edu](mailto:kedar.kirane@stonybook.edu))

*When sending emails, include **MEC641** in the subject line.*

**Office Hour:** Nakamura: Monday and Thursday 1:30 – 3:30PM at Light Engineering 137

Kirane: Tuesday and Thursday 1:30 – 3:30PM via Zoom (meetings will be set up on blackboard)

### Reference Books:

- T. L. Anderson, “**Fracture Mechanics: Fundamentals and Applications**”, CRC Press.
- Z. P. Bazant, and J. Planas. Fracture and size effect in concrete and other quasibrittle materials, 1997, vol. 16, CRC press.
- D. K. Felbeck and A. G. Atkins, “Strength and Fracture of Engineering Solids”, Prentice Hall.
- R. J. Sanford, “Principles of Fracture Mechanics”, Prentice Hall.
- Kare Hellan, “Introduction to Fracture Mechanics”, McGraw-Hill.
- David Broek, “Elementary Engineering Fracture Mechanics”, Martinus Nijhoff Pub.
- M. F. Kanninen and C. Poplar, “Advanced Fracture Mechanics”, Oxford Univ. Press.
- John W. Hutchinson, “Nonlinear Fracture Mechanics”, Technical Univ. of Denmark.
- Subra Suresh, “Fatigue of Materials”, Cambridge University Press
- L. B. Freund, “Dynamic Fracture”, Cambridge University Press

<b>Grading:</b>	Homework Assignments	30%
	Exam to be given in November	35%
	Course Project Report	35%

### Bulletin Description:

The mechanics of brittle and ductile fracture in engineering materials are studied. Major subjects are linear elastic fracture, elastic-plastic fracture, and fatigue crack analysis. Topics also include stress intensity factor, energy release rate, J-integral.

### Mode of Lectures:

The course is scheduled to be taught in-class. The lectures are planned to be available through Zoom Meeting with recording. Some lectures may be given through online through Zoom Meeting instead of in-class meeting. However, the details will be determined only after the class starts.

### Face Masks/Coverings:

Everyone participating in this class, must wear a mask/face covering at all times. Any student not in compliance with this will be asked to leave the class.

### Homework Assignments:

All the assignments are given on Blackboard. They may be turned in the class on the due date or uploaded on Blackboard. The assignments uploaded on the Blackboard will not be returned with comments.

**Exam:**

One exam is planned on the last meeting in late November. It will be given in class. Arrangements may be made for students who wish to take it online.

**Course Project:**

The course requires, each student to submit fracture mechanics related project report. The topic must be chosen and reported to the instructors by mid-semester. This will require written report and may also presentation (to be decided). The details will be announced once the class starts.

**Topics:**

*The exact number of lectures may change slightly.*

1. *Introduction – 1 lecture*

Engineering Materials, Various types of Fracture, Griffith Concept, Modes of Fracture

2. *Linear Elastic Fracture – 1 lecture*

Asymptotic Field, Stress Intensity Factors, Airy Stress Function, Fracture Toughness

3. *Energy Integrals – 1 lecture*

$J$ -integral, Conservation Integrals, Energy Momentum Tensor, Energy Release Rate

4. *Fracture in Bimaterials – 1 lecture*

Interface Fracture, Oscillatory Crack Tip Field, Thin Film Delamination

5. *Fracture in Composites (Kedar) – 2 lectures*

Fracturing of Fiber-reinforced Composites, Concrete, Rocks, Fracture process zone, Cohesive Crack Model, Fictitious Crack/Crack Band Model, Strain Softening and Regularization, Size Effect in Strength

6. *Elastic-Plastic Fracture – 1.5 lecture*

HRR-Field, Plasticity, Small Scale Yielding, Large Scale Yielding, Limit Analysis

7. *Crack Initiation and Growth – 1.5 lecture*

$J_{Ic}$  Measurement, Resistance Curve, Steady State

8. *Fracture in Soft Materials (Kedar) – 1 lecture*

Polymers, Elastomers, Crack Tip Fields for Neo-Hookean Solids

9. *Fatigue and Cyclic Fracture – 1.5 lecture*

Microstructure, Paris Law, Environmental Effects

10. *Dynamic Fracture – 1 lecture*

Stress Wave Loading, Dynamic Propagation Problems

11. *Applications and Other Topics – 1.5 lecture*

Computational, Three-Dimensional Fracture, etc.

### **Student Participation in University-Sponsored Activities**

By their participation in campus-related activities such as research conferences, dramatic or musical performances, intercollegiate athletic competitions, or leadership meetings, students make contributions to the University. In recognition of the students' commitment both to their regular academic programs and to related activities, the University makes every effort to accommodate unique situations.

Students are responsible for presenting a printed copy of semester obligations to all their professors at the beginning of the semester to alert them to activities that may present conflicts. Instructors are required to make arrangements for students to complete examinations, quizzes, or class assignments early or late if the student's participation in a University-related activity results in the student's absence from the class when such work is due. Some events occur only by invitation during the semester, and instructors should make accommodations for these students.

### **Final Examinations**

The academic calendar provides seven days each semester for a Final Examination Period. The last examination of the course, whether comprehensive or covering only a portion of the material, must be given during the Final Examination Period at the time designated for the course. Exceptions may only be granted by the dean of the faculty member's college for compelling academic reasons. Unit exams may only be given during the last week of the semester if a final examination is also given during the Final Examination Period. Instructors are reminded that students who request accommodation for religious reasons are entitled to that accommodation under New York State law. It is the responsibility of the student to plan class schedules to avoid conflicts with Evening Midterm exams and regularly scheduled classes, and to avoid conflicts with Final Exams. Final schedules may be found online at <http://www.stonybrook.edu/commcms/registrar/registration/exams.html>.

### **Student Accessibility Support Center Statement**

If you have a physical, psychological, medical or learning disability that may impact your course work, please contact Student Accessibility Support Center, 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 Student Accessibility Support Center. 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 is required to report any suspected instances of academic dishonesty to the Academic Judiciary. 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](http://www.stonybrook.edu/commcms/academic_integrity/index.html)

Examples include, *but are not limited to*, copying or plagiarizing class assignments including homework, reports, designs, and other submitted materials; copying or otherwise communicating answers on exams with other students; bringing unapproved aids, either in physical (written) or electronic form to an exam; obtaining copies of an exam prior to its administration, etc. Academic dishonesty violates both the ethical and moral standards of the Engineering profession and all infractions related to academic dishonesty will be prosecuted to the fullest via the CEAS CASA committee. For you, the honest student, academic dishonesty results in lower class curves, hence a depression in your GPA and class standing, while cheapening the degree you earn.

### **Critical Incident Management**

Stony Brook University expects students to respect the rights, privileges, and property of other people. Faculty are required to report to the Office of University Community Standards 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. Further information about most academic matters can be found in the Undergraduate Bulletin, the Undergraduate Class Schedule, and the Faculty-Employee Handbook.