MEC 536 Mechanics of Solids (3 credits) – Fall 2022

Instructor: Toshio Nakamura (toshio.nakamura@stonybrook.edu)

*When sending emails, include **MEC536** in the subject line.*

Lectures: Tuesdays 3:00 – 5:44pm, Melville Library N4000

Office Hour: Monday and Thursday 1:30 – 3:00pm, Light Engineering 137

Recommended Textbook:

Mechanics of Solids and Material by Asaro and Lubarda, Cambridge Univ. Press.

Other Related Books:

Applied Mechanics of Solids by Bower, CRC Press
Continuum Mechanics by Mase, Schaum Outlines Series, McGraw-Hill
An Introduction to Continuum Mechanics by Reddy, Cambridge
Elastic and Inelastic Stress Analysis by Shames and Cossarelli, Prentice-Hall
Introduction to the Mechanics of a Continuous Medium by Malvern, Prentice-Hall
Foundation of Solid Mechanics by Fung, Prentice-Hall
Deformation of Elastic Solids by Mal and Singh, Prentice-Hall (*out of print*)

Grading:

Homework	–	30%
Mid-Term Test (mid-late October?)	–	30%
Final Exam (12/13 at 11:15-1:45pm)	–	40%

Bulletin Description & Summary:

A unified introduction to the fundamental principles, equations, and notation used in finite deformation of solids, with emphasis on the physical aspects of the subject. Cartesian tensor representation of stress, principal values, finite strain, and deformation. Conservation of mass, momentum, and energy. Formulation of stress-strain relations in elasticity, and compatibility relations. The use of general orthogonal coordinate systems in the equations governing solids. Principles of virtual displacement and virtual work.

This course is designed to study the fundamentals of solid mechanics (e.g., stress, deformation) as well as to introduce various topics of the field (e.g., composites, plasticity and fracture mechanics). In Elasticity course (MEC541), 2D and 3D linear elastic problems will be solved with stress functions, displacement potentials and Laplace transform. There are also Plasticity (MEC543), Composites (MEC552) and Fracture Mechanics (MEC641) courses that cover the subjects more in-depth.

Necessary Background:

Two undergraduate courses in solid mechanics (equivalent to MEC363 and MEC455/530 at Stony Brook) that cover the following subjects. *Make sure you have the sufficient background to take the course.*

- *Basic understanding of stress and strain (e.g., formulations, Mohr's circle).*
- *Linear stress-strain relation – Hooke's law, Young's modulus, Poisson's ratio.*
- *Simple beam theory – bending moment, shear force of beams.*
- *Torsion of circular/ring cross-section.*
- *Plane stress and plane strain conditions –various stress & strain components.*
- *Strain energy and some energy-based principles.*
- *Stress function (Airy & Torsional).*

The course also uses Mathematica, *https://it.stonybrook.edu/software/title/mathematica* , etc.) to solve problems/equations.

Mode of Lectures:

The course is scheduled to be taught in-class.

Homework Assignments:

All the assignments are given on Blackboard. They must be turned in the class. Only under special circumstances, they may be uploaded on Blackboard with prior approval.

Course Outline

1. Introduction (0.5 class) – *A & L* (*Ch. 1 & 2*), *Mase, Handout*
   - Vector, Tensor and Indicial Notation
2. Review of Stress and Strain (0.5 class) – *Mase, Handout*
   - Equilibrium, Compatibility, Constitutive Equations
   - Strain Energy
   - Principle of Virtual Work
3. Deformation (2.5 classes) – *A & L* (*Ch. 4*), *Mase*
   - Deformation Gradient Tensor
   - Finite Strain Tensors
   - Strain-Displacement Equations
4. Analysis of Stress (1.5 classes) – *A & L* (*Ch. 5*), *Mase*
   - Balance Law
   - Cauchy's Stress Tensor
   - Equilibrium and Equations of Motion
5. Constitutive Equation (2 classes) – *A & L* (*Ch. 7*), *Mase*
   - Finite Elasticity
   - Anisotropic Solids
6. Elastic Problems (2 classes) – *A & L* (*Ch. 8*)
   - Navier's Equation
   - Uniqueness, Minimum Potential Energy
   - Simple Linear Elastic Boundary Value Problems
7. Plasticity (2 classes) – *A & L* (*Ch. 26*), *Handout*
   - Mises and Tresca Yield Criteria
   - Limit theorem, Simple Boundary Value Problems
8. Fracture Mechanics (1 class) – *A & L* (*Ch. 17 & 19*), – *Handout*
   - Linear Elastic Crack Tip Field, Stress Intensity Factor
   - Energy Release Rate, *J*-integral, Fracture Toughness

Student Accessibility Support Center Statement

If you have a physical, psychological, medical, or learning disability that may impact your course work, please contact the Student Accessibility Support Center, 128 ECC Building, (631) 632-6748, or via e-mail at: sasc@stonybrook.edu. They will determine with you what accommodations are necessary and appropriate. All information and documentation is confidential.

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. 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

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.

Assessment of Student Performance

• Homework assignments, examinations, and term papers should be evaluated and returned promptly. Written comments, explaining the instructor's criteria for evaluation and giving suggestions for improvement, should be provided.

• Instructors are responsible for providing students with appropriate and timely notification about their academic performance in a course. An examination or other assessment measure should be administered, graded, and returned to students before the end of the ninth week of classes.

• Examinations and term papers submitted at the end of the term should be graded and either returned to students or retained for one semester.

• Any change to the course grading policy during the semester must be announced and made available to all students enrolled in the course. Assigning additional work to individual students who wish to improve their grades, during or after the semester, is prohibited.

• Instructors must observe the Final Examination Schedule available at http://www.stonybrook.edu/registrar. Instructors of courses taught on the semester schedule may only give a unit exam in class during the last week of the semester if a final examination is also given during the Final Examination Period.

• Instructors must observe state laws, federal laws, and University policies regarding accommodations as noted in the Bulletin (e.g., student participation in University-sponsored activities or equivalent opportunity/religious absences). Accommodations such as make-up exams, assignments, or other coursework that fall outside of the purview of these laws and policies are at the discretion of the instructor.

Professional Conduct and Interaction with Students

• Instructors must report all suspected occurrences of academic dishonesty to the Academic Judiciary Committee (for classes in the College of Arts and Sciences, College of Business, School of Marine and Atmospheric Sciences, and School of Journalism) or the Committee on Academic Standing and Appeals (for classes in the College of Engineering and Applied Sciences).

• Instructors should always be aware that in teaching and advising they represent the University. They are bound by the University's sexual harassment policies. Instructors are also bound by University policies that prohibit any consensual relationships with students that might compromise the objectivity and integrity of the teacher-student relationship. Examples include romantic, sexual, or financial relationships.

• Instructors should strive to maintain the privacy and confidentiality of students' examinations, homework, and final grades.

• In dealing with students, instructors should be polite, helpful, and fair. They should take into account the wide range of cultural factors and physical challenges that can affect learning and should attempt to help students overcome any disadvantages.