# MEC 536 Mechanics of Solids – Fall 2020

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

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

**Lectures**: Tuesdays 3:00 – 5:50pm, Humanities 3017

**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**:

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| Homework | – | 30% |
| Mid-Term Test (late October?) | – | 30% |
| Final Exam (12/15 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 computer software (Mathematica, Matlab, etc.) to solve problems/equations.

**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.

## 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 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

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.