MEC 455/530 APPLIED STRESS ANALYSIS

Spring Semester 2022

Credit: 3 credits

Prerequisite: MEC 363 or equivalent course

Lectures: Mon/Wed 4:25 – 5:45pm at Frey Hall 309

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

Include MEC455 or 530 in the subject line when emails are sent

Office Hour: Mon, Thu 1:30 – 3:00PM at Light Engineering 137

TA: Xiaoqiang Xu (Xiaoqiang.Xu@stonybrook.edu) Tue, Fri 2-4pm at Heavy Engin. 135

Text/Primary Reference Book:

- *Applied Mechanics of Solids*, Alan F. Bower, CRC Press (2009).

Other Related Books:

- *A First Course in Finite Elements*, J. Fish & T. Belytschko, Wiley (2007).
- *Advanced Strength and Applied Stress Analysis*, R. G. Budynas, McGraw-Hill (1998).
- *Deformable Bodies and Their Material Behavior*, H. W. Haslach, R. W. Armstrong, Wiley (2004).
- *Advanced Mechanics of Materials*, R. Solecki and R. J. Conant, Oxford (2003).
- *Elasticity in Engineering Mechanics* 2nd ed. A. P. Boresi and K. P. Chong, Wiley (2000).
- *Advanced Mechanics of Materials*, R. D. Cook and W. C. Young, Prentice Hall (1998).
- *Continuum Mechanics*, G. E. Mase, *Schaum's Outline Series*, McGraw-Hill (1969)
- Textbook for MEC363 (*textbook for MEC410 is also useful*).
- *Finite Elements in Solids and Structures*, R. J. Astley, Chapman & Hall (2001).
- *Introduction to Finite Elements in Engineering*, T. Chandrupatla & A. Belegundu, Prentice (2002).
- *Finite Element Analysis*, G. R. Buchanan, *Schaum's Outline Series*, McGraw-Hill (1994)

Homework: Homework and/or computer assignments are given about every week.

Exams: Two mid-term tests will be given (in March & April/May). The final will be given in a form of finite element project (due 5/17/2022 final exam date).

Grading:

Homework (including computer assignments)	37% (MEC530 has an extra HW)
Two Mid-Term Tests	42%
Final FE Project Exam	21%

Bulletin Description:

Advanced mechanics of solids and structures. Elastic boundary value problems are analyzed with various solution techniques including finite element method. Major topics are stress and strain, FEM formulations, material behaviors, 2D elastic problems, stress function and fracture. Detailed studies of structural components are carried out with FEM with emphasis on optimal mesh design and proper interpretations of computed results.

Course Learning Objectives:

The course is designed to learn the fundamentals and various solution procedures for structural problems including *analytical method*s and *finite element method*. Through understanding tensor algebra, solution formulations and various materials behaviors, students will be effectively utilized these solution techniques to determine stress and deformation fields of engineering structures and components. The course also prepares students to become professional engineers through detailed analysis/project reports.

Finite Element Program:

The course will use ABAQUS finite element software. A student edition of the program can be downloaded. **Note this version only runs on Windows OS not on Mac OS**. If you have a Mac, you will need to install Windows (e.g., via Boot Camp, VirtualBox). To download the software, first create "DS Passport" by accessing to http://academy.3ds.com/software/simulia/abaqus-student-edition/ and follow the necessary procedure. **Do this immediately to download ABAQUS.** It is strongly encouraged to go over **ABAQUS Tutorials.**

Assignments

All the assignments must be carried out ***independently*** and submitted at the start of class on the due dates. The format must follow the instructions on the Blackboard. Only under emergency, they can be upload to the Blackboard with prior approval from the instructor.

University Rule:

Students are expected to attend every class, report for examinations and submit major graded coursework as scheduled. If a student is unable to attend lecture(s), report for any exams or complete major graded coursework as scheduled due to extenuating circumstances, the student must contact the instructor as soon as possible. Students may be requested to provide documentation to support their absence and/or may be referred to the Student Support Team for assistance. Students will be provided reasonable accommodations for missed exams, assignments or projects due to significant illness, tragedy or other personal emergencies. In the instance of missed lectures or labs, the student is responsible for getting teaching materials online or from classmates. Please note, all students must follow Stony Brook, local, state and Centers for Disease Control and Prevention (CDC) guidelines to reduce the risk of transmission of COVID. For questions or more information

Course Schedule

WEEK#	COVERED TOPICS	Chapters in *Applied Mechanics of Solids*
1	Review of Stresses and Strains, Vectors and Tensors with Indicial Notation	Chap 2, Appendix C
2	**Energy Formulation** Fundamentals of FEM, minimum potential energy	Chap 7
3, 4	**Finite Element Formulations** Interpolation function stiffness matrix, boundary condition	Chap 8
5	Stress, Deformation and Strain Equilibrium and compatibility conditions	Chap 2
6	Material Behavior Constitutive equations, anisotropic materials, strain energy	Chap 3
7	Simple Elastic Problems Axial loading, deformation under gravity	Chap 4
7	2-D Elasticity Plane stress/strain, Airy stress function, line load, plate with a hole	Chap 5
8	**FE Modeling and Mesh Design of 2D** CST elements, isoparametric elements, boundary conditions	Chap 7, 8
9	**FE Final Project Topic** Fracture mechanics, mesh construction	Chap 6
10	**FE Analysis Techniques,** Thick-Walled Cylinder Choosing suitable elements. Pressurized cylinders, press-fit.	Chap 4
11	Plasticity Yielding condition, von Mises criterion	Chap 7
12	Fracture mechanics and review of the course	
13	Test and preparation for the final project	

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.

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 Student Conduct and Community Standards any disruptive behavior that interrupts their ability to teach, compromises the safety of the learning environment, or inhibits students' ability to learn. Until/unless the latest COVID guidance guidance is explicitly amended by SBU, during Spring 2022 "disruptive behavior" will include refusal to wear a mask during classes.

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.

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/