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ME 315-002: Stress Analysis

Kwabena Narh

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ME-315-002 STRESS ANALYSIS SPRING 2021

Virtual Class Day and Time: Monday, Thursday: 04:00 PM - 05:20 PM, via WebEx

Login Information: <https://njit.webex.com/meet/narhnjit.edu>

Virtual classroom Access Code: 920 274 937

Host: Prof. K. Albert Narh

Virtual Office Hours: Wednesday 2:00 PM - 3:00 PM, via WebEx (same login info and Access code).

There will be no office hours a day either before any scheduled exam or during the exam day.

Textbook and Reference Book: See page 4:

Homework Homework Assignments are due one week after they are assigned. Solutions to **SOME** homework problems will be reviewed in class. All Homework and Extra Credit Problems will be posted on canvas

NOTE: *All homework and extra credit assignments must be submitted on the due date, unless there was prior excuse, which must go through the Dean of Students.*

Exams There will be three exams during the semester. There will be **NO** make-up exams.

NOTE: ALL EXAMS WILL BE VIA WEBEX AND WIL BE PROCTORED BY ME, YOUR INSTRUCTOR

Final Grade Composition: Course average is based on exams and homework.

<u>Item</u>	<u>Weight (%)</u>
Examination 1	30
Examination 2	30
Homework	10
Final Examination	30
<hr/>	
	100
<i>Extra Credit</i>	<i>2 points (to be added to the Final Grade)</i>

Extra Credit Assignments:

Extra-Credit Assignments will be given periodically. There will also be extra-credits for class participation. These Extra-Credits are added to the final Grade Points.

Grading Scale A (90-100); B+ (85-89); B (80-84); C+ (75-79); C (70-74); D (65-69); F (<65)

ACADEMIC INTEGRITY

Academic Integrity is the cornerstone of higher education and is central to the ideals of this course and the university. Cheating is strictly prohibited and devalues the degree that you are working on. As a member of the NJIT community, it is your responsibility to protect your educational investment by knowing and following the academic code of integrity policy that is found at: <http://www5.njit.edu/policies/sites/policies/files/academic-integrity-code.pdf>.

Please note that it is my professional obligation and responsibility to report any academic misconduct to the Dean of Students Office. Any student found in violation of the code by cheating, plagiarizing or using any online software inappropriately will result in disciplinary action. This may include a failing grade of F, and/or suspension or dismissal from the university. If you have any questions about the code of Academic Integrity, please contact the Dean of Students Office at dos@njit.edu

Note: Solutions for Problems in red will be posted on canvas after review in class. **Do not submit Textbook Problems; they should be used as Practice Problems.**

Week	Subject	Articles	Problems
1, 2 1/21-1/28	Introduction, stress tensor; Equilibrium, transformation of stresses, principal stresses.	1.1 to 1.7 1.8 to 1.10	1.1, 1.2 1.13, 1.14, 1.21
3 2/01, 2/03	Mohr’s circle for stress Three-dimensional stresses	1.11 1.12 to 1.14	1.26, 1.27, 1.41 1.55, 1.66
4 2/08, 2/10	Normal and shearing strains, strain tensor, compatibility Transformation of strains	2.1 to 2.4 2.5 to 2.6	2.1, 2.3, 2.5, 2.7 2.9, 2.15, 2.17
5 2/15, 2/17	Engineering Materials, Stress-strain relations Strain gages	2.7 to 2.10	2.36, 2.38, 2.40, 2.41, 2.42
6 2/22, 2/24	Strain energy Saint Venant’s principle	2.11 to 2.14	2.52, 2.54, 2.59, 2.66, 2.67
7 2/29, 3/01	Plane stress, plane strain Airy stress function	3.1 to 3.4 3.5 to 3.6	3.1a, 3.2, 3.3, 3.4 3.5, 3.8, 3.10, 3.16
8 3/08 3/10	Problems Exam #1	----	----
9 3/14	SPRING RECESS	SPRING RECESS	SPRING RECESS
10 3/22, 3/25	Stress and strain in polar coordinates Stress concentration	3.8 to 3.9 3.10 to 3.11	3.20, 3.24 3.36
11 3/29, 3/31	Failure theories Comparison of yielding criteria	4.1 to 4.8 4.9 to 4.12	4.4, 4.5 (Table D1), 4.6, 4.7, 4.14, 4.9a, 4.10, 4.25, 4.27a
12 4/05, 4/08	Axisymmetrically loaded members Shrink fit, composite cylinders	8.1 to 8.4 8.5	8.1, 8.4, 8.6 (Eq. 8.14), 8.10, 8.11 (Eq. 8.18), 8.13 (Hk’s law; Eq. 8.8) 8.21, 8.22, 8.32 (Fig. 8.11, and Ex. 8.5)

4/12	Review Problems for Exam 2	----	----
4/15 (Thur.)	Exam #2		
13 4/19	Rotating disks;	Rotating disks;	8.36 (Eq. 8.30), 8.37, 8.38, 8.39
14/22, 4/26	Energy methods, Castigliano's Theorem ♦ Virtual Work, Ritz method ♦	10.1 to 10.4 10.7 10.8 to 10.11	10.2, 10.3, 10.4, 10.5 10.41, 10.42, 10.43
15 4/29-5/03	Elastic stability of columns ♦ Actual columns ♦	11.1 to 11.6 11.7 to 11.9	11.2 11.12, 11.13, 11.18, 11.21, 11.35
TBD	Final Exam	Time: TBD	

Course Syllabus

COURSE NUMBER	ME 315		
COURSE TITLE	Stress Analysis		
COURSE STRUCTURE	(3-0-3) (lecture hr/wk - lab hr/wk – course credits)		
COURSE COORDINATOR	A. D. Rosato		
COURSE DESCRIPTION	This course provides the theoretical background to stress analysis in mechanical design. Topics include two-dimensional elasticity, transformation of stress and strain, plane stress and plane strain problems, axisymmetric members, buckling criteria and failure theories.		
PREREQUISITE(S)	ME 215 – Engineering Materials and Processes; Mech 237 – Strength of Materials; Math 222 – Differential Equations		
COREQUISITE(S)	None		
REQUIRED, ELECTIVE, OR SELECTED ELECTIVE	Required		
REQUIRED MATERIALS	Advanced Mechanics of Materials and Applied Elasticity 5th edition. by A.C Ugural and S.K. Fenster, Prentice Hall, 2012.		
Materials (not Required)	Mechanics of Materials, R. Craig (Wiley), 3rd edition. Power-point lecture notes provided by instructor		
COMPUTER USAGE	MS Excel; MS Word for Homework Assignments		
COURSE LEARNING OUTCOMES/ EXPECTED PERFORMANCE CRITERIA:	Course Learning Outcomes	SOs*	Expected Performance Criteria
	1 Use Mohr’s circle to fully analyze the stress/strain state in a body	1,2	Exam Question (80% of the students will earn a grade of 70% or better on this question)
	2. Explain how Mohr’s circle is related to the stress transformation equations	1,2	Homework Assignment (80% of the students will earn a grade of 70% or better on this assignment)
	3. Solve stress /strain eigenvalue problems	1,2	Exam Question (same as 1)
	4. Apply various failure theories needed in the design process	1,2	Exam Question (same as 1)
	5. Explain and describe the relationship between stress and strain tensor	1	Homework Assignment (same as 2)

	6. Define plane stress/ plane strain Explain Airy’s Stress function for 2D problems	1	Homework Assignment (same as 2)					
	7. Develop equations for and solve axisymmetric problems - plate with hole, point loads on a half-space	1	Exam Question (same as 1)					
	8. Solve problems involving thick-walled cylinders, shrink-fits, and rotating disks	1,2	Exam Question (same as 1)					
	9. Describe the concepts of strain energy, deformation work and explain Betti’s reciprocity theorem	1	Homework Assignment (same as 2)					
	10. Explain Castigliano’s theorems and apply them to problems on beam deflections, and rotations	1,2	Exam Question (same as 1)					
	11. Apply Castigliano’s theorems to indeterminate structures	1,2	Exam Question (same as 1)					
	12. Explain elastic stability related to column buckling	1,2	Homework Assignment (same as 2)					
	13. Solve simple column buckling problems	1,2	Exam Question (same as 1)					
CLASS TOPICS	<ol style="list-style-type: none"> 1. Introduction, stress tensor; Equilibrium, transformation of stresses, principal stresses. 2. Mohr’s circle for stress, Three-dimensional stresses. 3. Normal and shearing strains, strain tensor, compatibility, Transformation of strains. 4. Stress-strain relations. 5. Strain energy, St. Venant’s principle. 6. Plane stress, plane strain, Airy stress function. 7. Stress & strain in polar coordinates, Stress concentration. 8. Axisymmetrically loaded members, Shrink fit, composite cylinders, rotating disks. 9. Theories of Failure. 10. Energy methods, Castigliano’s Theorem, Virtual Work. 11. Elastic Stability of Columns. 							
STUDENT OUTCOMES (SCALE: 1-3)	1	2	3	4	5	6	7	3 –
	3	3	-	-	-	-	-	
	Strongly supported 2 – Supported 1 – Minimally supported							

* Student Outcomes