Fall 2019

ME 315-001: Stress Analysis

K. A. Narh

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ME-315-001 STRESS ANALYSIS FALL 2019

Tuesday, Thursday: 1:00 PM – 2:20 PM, MEC 221

INSTRUCTOR: Dr. K.A. Narh, 202 MEC
Phone: (973) 596-3353; Email: narh@njit.edu

TEXTBOOK: Advanced Mechanics of Materials and Applied Elasticity 5th edition, A.C. Ugural and S.K. Fenster, Prentice Hall (2012).

REFERENCE BOOK: Mechanics of Materials, R. Craig (Wiley), 3rd edition

HOMEWORK: Homework Assignments are due one week after they are assigned. Solutions to **SOME** homework problems will be reviewed in class

NOTE: ***All homework and extra credit assignments must be submitted in person in class, 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.

PREREQUISITE BY TOPIC:

1. Differential Equations (Math 222)
2. Strength of Materials (Mech 237)
3. Engineering Materials and Processes (ME 215)

FINAL GRADE: Course average is based on exams and homework.

Item	Weight (%)
Examination 1	30
Examination 2	30
Homework	10
Final Examination	30

OFFICE HOURS: Wednesday 2:00 PM - 3:00 PM, or by appointment only. **There will be no office hours a day either before any scheduled exam or during the exam day.**

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: The grading scale will be as follows: A (90-100); B^+ (85-89); B (80-84); C^+ (75-79); C (70-74); D (55-69); F (<55)

CLASS RULES: Late Homework submissions are **NOT ALLOWED**. Sleeping in class is unacceptable. **TURN OFF ALL CELL PHONES**

NJIT STUDENT HONOR CODE **THIS WILL BE STRICTLY ENFORCED.**

NOTE:All the above items may be subject to change on the instructor's discretion. (For example, the Grading Scale may be adjusted to reflect the class average.)

I strongly recommend that you purchase and use a quality graphing calculator capable of performing algebraic manipulation for this course. A TI NSpire Cx-CAS is TI's top of the line calculator, and is fantastic for this course. The TI-89 Titanium is nearly as capable, somewhat cheaper, and quite a bit more available.
Learning to use the features of your calculator is your responsibility.

ASSIGNMENT SHEET

ME 315-001 STRESS ANALYSIS FALL 2019

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Textbook:– Advanced Mechanics of Materials and Applied Elasticity 5th edition.
By A.C Ugural and S.K. Fenster, Prentice Hall, 2012
Prerequisites: Math 222, Mech 237, ME 215
Note: Solutions for Problems in red will be posted on CANVAS after review in class.

Week	Subject	Articles	Problems
1, 2 9/3, 9/10	Introduction, Review of fundamentals: forces and their distributions on a body, Static analysis: Internal Moment Equations via Free-body diagrams Stress tensor Equilibrium equations, 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 9/17	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 9/24	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 10/1	Engineering Materials, Stress-strain relations Strain gages	2.7 to 2.10	2.36, 2.38, 2.40, 2.41, 2.42
6 10/8	Strain energy Saint Venant's principle	2.11 to 2.14	2.52, 2.54, 2.59, 2.66, 2.67
7 10/17	Review Problems 10/15 Exam #1	----	----
8 10/22	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
 10/24	Stress and strain in polar coordinates Stress concentration	3.8 to 3.9 3.10 to 3.11	3.20, 3.24 3.36
9 10/29 10/31	 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, 4.9a, 4.10 4.25, 4.27a
10 11/5 11/7	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)
11 11/12	 Rotating disks	 8.6 to 8.8	 8.36 (Eq. 8.30), 8.37, 8.38, 8.39
12 11/26	Review Problems 11/14, 11/19 Exam #2	----	----
12 11/28	THANKSGIVING RECCESS	THANKSGIVING RECCESS	THANKSGIVING RECCESS
13 12/03, 12/05	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
14 12/10, 12/12	Elastic stability of columns Actual columns Final Exam Review	11.1 to 11.6 11.7 to 11.9 ----	11.2 11.12, 11.13, 11.18, 11.21, 11.35 ----
15	12/14 Final Exam	----	----

ABET Format 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	Mechanics of Materials, R. Craig (Wiley), 3rd edition.
Materials (not Required)	Power-point lecture notes provided by instructor
COMPUTER USAGE	MS Excel; MS Word for Homework Assignments

COURSE LEARNING OUTCOMES/ EXPECTED PERFORMANCE CRETERIA**:**

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 75% 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 75% 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	1,2	**Exam Question** (same as 1)

	rotating disks		
	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

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