



**South Dakota School of Mines & Technology
College of Engineering**

**ME-216 Introduction to Solid Mechanics
Fall 2009**

Instructor

Karim Heinz Muci, Ph.D.

Professor, Mechanical Engineering Department

Co-Director, Computational Mechanics Laboratory (CML)

Office: Civil & Mechanical Engineering Bldg., Computational Mechanics Laboratory, CM-171

Phone: (605)-394-2430 Fax: (605)-394-2405

E-mail: Karim.Muci@sdsmt.edu

Office Hours

Monday, Wednesday and Friday, 11:00 am – 12:00 noon

Tuesday and Thursday, 1:00 pm – 3:00 pm

Other times may be possible making and appointment at the end of one of the lecture hours.

Lecture Hours

Monday, Wednesday and Friday, 10:00 am – 10:50 am

Classroom

C-302

Web Site

<http://speedy.sdsmt.edu/~kmuci/>

In the “Course Materials” section of this web site the instructor will be posting during the semester homework assignments and other important information. The students must check this web site on a regular basis.

Credits

3

Prerequisites

EM-214 Statics

Textbook

- R. C. Hibbeler: *Mechanics of Materials*. 7th Edition. Pearson Prentice Hall, 2008.

Expectations for Incoming Students

- The students are expected to enter the class with a good working knowledge of developing free-body diagrams and the principles of Statics.
- Basic computer skills, such as the ability to work in the MS Windows environment, are a prerequisite.

- The students should be able to comfortably work with MS Excel and MS Word.
- The students should be able to use the software Mathcad (or another program with similar capabilities) or they should be able to program in their favorite programming language.

Student Effort

During each week, the student is expected to spend between six and eight hours outside of the classroom in preparation for class, studying the textbook and lecture notes, and solving homework assignments.

Course Description (According to the Undergraduate Catalog)

Definition of stress. Transformations and states of stress; plane stress, plane strain, octahedral stresses, three-dimensional stresses and principal stresses in two and three dimensions. Strain analysis, strain measurements and rosette analysis. Generalized Hooke's law, orthotropic materials, and an introduction to composite materials. Analysis of thin and thick cylinders. Statically indeterminate members. Torsional loading of shafts, power transmission and the shaft equation. Torsional loads in non-circular components and thin tubes. Stress concentrations and combined loads.

Course Goal

The goal of the course is to provide an introduction to solid mechanics. Focusing on linear elasticity and small deformations, basic concepts related to stress, strain and constitutive relations are presented in the context of two-dimensional states of stress and strain (i.e., plane stress and plane strain). The cases of axially loaded members and torsion of circular shafts are used to apply the concepts learned to two loading conditions typically encountered in the analysis of mechanical components. Figure 1 illustrates the topic areas covered in the course and indicates the next mandatory courses in the solid mechanics sequence.

Course Objectives

After taking this course the student should be able to:

- Apply basic concepts, definitions and formulas for the case of plane stress to the solution of solid mechanics problems.
- Apply basic concepts, definitions and formulas for the case of plane strain to the solution of solid mechanics problems.
- Have a basic understanding of how strain gages are used to measure the strains at a point on the surface of a body.
- Use the constitutive relation for linear elastic and isotropic materials in the solution of plane stress and plane strain problems.
- Determine the deformation and the state of stress in axially loaded members.
- Apply the concept of stress concentration to axially loaded members to take into account the effects of stress raisers.
- Solve simple statically indeterminate problems involving axially loaded members.
- Determine the angle of twist and the shearing stress in circular shafts subjected to torsion.
- Apply the concept of stress concentration to circular shafts subjected to torsion to take into account the effects of stress raisers.
- Solve simple statically indeterminate problems involving circular shafts subjected to torsion.

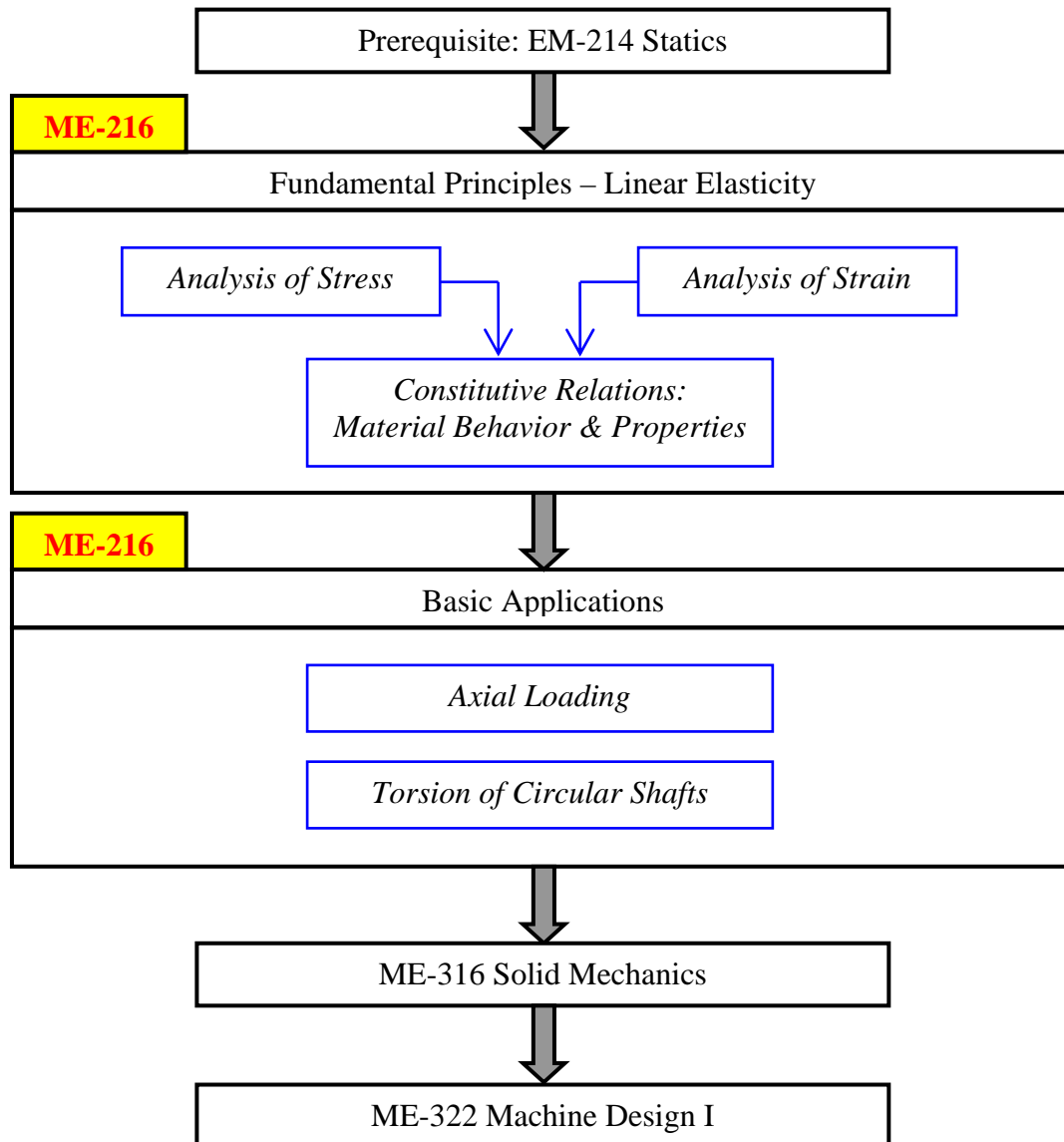


Figure 1. Topic areas covered in the course and next courses in the sequence

Topics

1. Analysis of Stress
 - Definition of stress
 - Average normal stress in an axially loaded bar
 - Average shear stress
 - Allowable stress
 - Plane stress
 - Stress transformation equations for a state of plane stress

- Principal stresses and maximum in-plane shear stress for the case of plane stress
 - Mohr's circle for the case of plane stress
 - Absolute maximum shear stress
2. Analysis of Strain
- Deformation
 - Definition of strain
 - Plane strain
 - Strain transformation equations for a state of plane strain
 - Principal strains and maximum in-plane shearing strain for the case of plane strain
 - Strain rosettes
3. Material Properties and Stress-Strain Relationships
- The tension and compression test
 - The stress–strain diagram
 - Stress–strain behavior of ductile and brittle materials
 - Hooke's law
 - Strain energy
 - Poisson's ratio
 - The shear stress–strain diagram
 - Generalized Hooke's law
 - Thermal strain
4. Axial Loading
- Saint-Venant's principle
 - Elastic deformation of an axially loaded member
 - Principle of superposition
 - Statically indeterminate axially loaded member
 - The force method of analysis for axially loaded members
 - Thermal stress
 - Stress concentration
5. Torsion
- Torsional deformation of a circular shaft
 - The torsion formula
 - Power transmission
 - Angle of twist
 - Statically indeterminate torque-loaded members
 - Stress concentration

Expected Outcomes

After taking this course the student should be able to:

1. Understand basic definitions and sign conventions for normal and shearing stresses and strains.
2. Use the stress transformation equations for the case of plane stress.
3. Find principal stresses, maximum in-plane shearing stress and absolute maximum shearing stress for the case of plane stress.
4. Use the strain transformation equations for the case of plane strain.
5. Find principal strains and maximum in-plane shearing strain for the case of plane strain.
6. Understand the difference between plane stress and plane strain.
7. Use the measurements from a strain rosette to determine the strain components at a point on the surface of a body.
8. Understand the role of the stress-strain diagram in characterizing the mechanical behavior of a material.
9. Identify the mechanical properties used to characterize the behavior of linear elastic isotropic materials.
10. Use the generalized Hooke's law to relate the components of stress and strain.
11. Quantify the strains induced by a change in temperature.
12. Solve problems involving axially loaded members.
13. Apply static stress concentration factors to determine the maximum stress in axially loaded members with stress raisers.
14. Solve problems involving circular shafts subjected to torsion.
15. Apply static stress concentration factors to determine the maximum stress in circular shafts with stress raisers subjected to torsion.

Computer Usage

- All students must have and regularly read a SDSM&T e-mail account. During the semester, the instructor may send important information to the students via e-mail.
- Use of the software Mathcad.

Important note:

You may use another program that has capabilities similar to the ones provided by Mathcad. However, the instructor won't be able to help you if you run into problems while trying to solve a homework assignment with that software. Also, the instructor may grade your homework taking only into account your final results.

- Some assignments may require electronic submission of work.
- Students may be required to use various computer tools, such as spreadsheets and word processing.

Grading

Exam 1	25 %	
Exam 2	30 %	(comprehensive)
Exam 3 (Final Exam)	35 %	(comprehensive)
Homework	10 %	(each may have a different weight based on difficulty)

Grading Scale

Grade	A	B	C	D	F
Average (%)	90-100	80-89	70-79	60-69	< 60

Exam Schedule

<i>Exam</i>	<i>Date</i>	<i>Time</i>	<i>Place</i>
1	Friday, October 9, 2009	10:00 am – 10:50 am	C-302
2	Friday, November 13, 2009	10:00 am – 10:50 am	C-302
3	Tuesday, December 15, 2009	10:00 am – 11:50 am	C-302

Academic Integrity

Students are expected to perform to a high standard of honesty and integrity in this course. Failure to do so will result in a final grade of “F” in addition to all the applicable sanctions according to all the rules and regulations currently in force at SDSM&T.

Note: According to the undergraduate catalog, academic dishonesty shall be defined to include all forms of cheating, fraud, plagiarism, or knowingly furnishing false information.

Attendance Policy

- Class attendance is mandatory: Every student is expected to attend each lecture.
- You must notify the instructor via e-mail and ahead of time (when possible) if you will be absent from class.
- Missing three or more class sessions may result, at the instructor’s discretion, in a final grade of “F” for the course.
- In general, only the following will be considered by the instructor as excused absences:
 - ✓ Medical emergencies.
 - ✓ Mandatory participation of the student in a school-sponsored event as described in the undergraduate catalog. (Note: In this situation, the student must follow all the guidelines and procedures specified in the undergraduate catalog).

Note: The instructor will consider all other circumstances on a case-by-case basis.

- If for some reason a student misses one class session, it is the student’s responsibility to find out which material was covered and which assignments were given.

Class Cancellation Policy

If a class is missed due to weather or instructor’s absence, anything planned for that class (homework due, exam, etc.) will occur during the next class session.

Homework Policies:

- Unless specified otherwise by the instructor, all the homework assigned during one week will be turned in the next Friday at the beginning of the class.
- Homework assignments are due at the beginning of the lecture on the assigned due date.
- Late homework will not be accepted. Since the number of homework assignments is relatively few, it is very important to submit all of them.
- Unless specified otherwise by the instructor, homework assignments will be carried out in teams of two or three students.
- The procedure to carry out a homework will be as follows: (1) Each team member will do his/her

best effort to solve on his/her own all the assigned problems, (2) the team members will meet and discuss the solution for each one of the problems, (3) the team will document in a very professional fashion the solution for each one of the problems, and (4) the team will determine the % of participation of each one of its members.

- If a student does not participate in an active fashion in the completion of a homework assignment, his/her name must not appear in the cover page of that assignment. If this rule has been violated, all the team members may receive a grade of “F” for the course.
- The instructor may choose only a portion of a homework assignment to grade, with the grade for that portion counting for the entire homework grade. No advance notice will be given as to which portion of a homework will be graded.
- The grade that each student will receive for a homework assignment will be the grade given by the instructor or GTA times the % of participation of the student.
- Homework submissions: (1) must not be done on spiral-edged paper; (2) must have all problems clearly labeled, neatly presented, and presented in the order in which they appear in the book; and (3) must be stapled in the upper left corner (if more than one page). The name of each one of the team members must be written at the top of the first page and the % of participation of each student in the homework assignment must be clearly stated.
- Preferred paper for homework assignments is engineering paper.

Other Policies:

- If a student is found working on homework or projects corresponding to this or any other course during one of the lectures, he/she will automatically receive a grade of zero in all the homework assignments given during the semester. No exceptions will be made!
- Homework submitted electronically at the request of the instructor must be properly submitted. Failure to do so will result in a grade of zero for the subject item.
- While consulting fellow students outside of the classroom to understand the material is encouraged, each homework, project, or exam must represent work done only by the student (or by the team members, if the activity was carried out in teams at the request of the instructor). If this rule has been violated, all parties involved will receive the sanctions described in the section “Academic Integrity” of this syllabus.
- In the solution of any homework/exam problem that has a numeric answer, you must include the appropriate units in all the steps of the solution process and in the final answer. Failure to do so will automatically result in no credit given for that problem.
- The reading assignments I give during a class period should be completed *before* the following class period. In class I will concentrate on some demonstrations and on doing blackboard examples that will highlight key aspects of your reading. I will not cover point-by-point the reading material.
- I assume that you have studied in full detail all the solved examples presented in the textbook for each one of the topics that we are covering in class.
- In some cases, I will only highlight the solution process for an example problem that I present in class. You must try to solve those problems on your own before the next class session.
- You are encouraged to solve on your own as many problems from the textbook as possible in order to make sure that you understand the topics covered in class.
- Calculators will be required for the exams.
- All the exams will be closed book and closed notes.

- There will be no makeup exams unless a student missed an exam due to a medical emergency or mandatory participation in a school-sponsored event. If you miss an exam due to other reasons, your grade in that exam will be zero.
- Grading of all materials will be strongly influenced by legibility and quality of presentation. If I cannot read it easily then it is wrong and the grade will be zero!
- Failure to draw a free-body diagram where one is appropriate for any given homework/exam problem will result in an automatic 50% deduction for that problem – even if the answer obtained is correct!
- Requests for re-grades on homework or exams must be submitted in writing within one week of the class in which I return the item on which you question the grade. Your request must explain in a very complete and detailed fashion which one is the question that you have regarding the grade. In this event, the entire homework/exam will be re-graded with possible adjustment in either direction.
- Items not claimed the first time I return them to the class must be picked up in my office within one week of the class in which I attempted to return it. Items not picked up after one week will be disposed of.
- Final exams will not be returned to the students. However, you can see your final exam if you stop by my office between the time I have the final exams graded and the end of the semester. After the end of the semester, all the final exams will be disposed of.
- Near the end of the semester a record of grades to date may be distributed to the students. If that is the case, each student should verify all grades and calculations. Any discrepancies observed by the student must be called to my attention by the next class and must be supported by graded materials. The instructor may correct any errors at that time.

General Policies for Assignments Carried Out in Teams at the Request of the Instructor:

- It is expected that all the team members will be actively involved in the completion of the assignment.
- If a student does not fully participate in the completion of an assignment, his/her name must not appear in the cover page of that assignment and a written notification signed by the other team members must be given to the instructor. Under these circumstances, the student will receive a grade of zero in that particular assignment. If this rule has been violated, all the team members may receive a grade of “F” for the course.
- It is the responsibility of each team member to carefully read the final document that will be turned in to the instructor and make sure that he/she completely agrees with all its contents.

Freedom in Learning Statement

Under Board of Regents and University policy student academic performance may be evaluated solely on an academic basis, not on opinions or conduct in matters unrelated to academic standards. Students should be free to take reasoned exception to the data or views offered in any course of study and to reserve judgment about matters of opinion, but they are responsible for learning the content of any course of study for which they are enrolled. Students who believe that an academic evaluation reflects prejudiced or capricious consideration of student opinions or conduct unrelated to academic standards should contact the dean of the college which offers the class to initiate a review of the evaluation.

Use of Electronic Devices

Please turn off your cell phone before class starts. No text messaging in class. No headphones. If you wish to use a laptop in this class it should be only for the purpose of note taking or if at the request of the instructor the laptop is being used for a specific learning activity related to the course. Failure to follow this policy will be considered a form of cheating and a breach of academic integrity. Note that according to “Policy Governing Academic Integrity” in the SDSM&T Undergraduate Catalog, the instructor of record for this course has discretion of how acts of academic dishonesty are penalized, subject to the appeal process, and that “Penalties may range from requiring the student to repeat the work in question to failure in the course.” No other use of any other electronic/computer media is allowed during class time.

Students with Special Needs

Students with special needs or requiring special accommodations should contact the instructor, Dr. Karim Heinz Muci, at 394-2430, and/or the campus ADA coordinator, Jolie McCoy, at 394-1924, at the *earliest* opportunity.



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ME-216 Introduction to Solid Mechanics

**Topic Sequence:
Mechanics of Materials, 7th Edition, R.C. Hibbeler**

1. Stress

- 1.1. Introduction
- 1.2. Equilibrium of a Deformable Body
- 1.3. Stress
- 1.4. Average Normal Stress in an Axially Loaded Bar
- 1.5. Average Shear Stress
- 1.6. Allowable Stress

9. Stress Transformation

- 9.1. Plane-Stress Transformation
- 9.2. General Equations of Plane-Stress Transformation
- 9.3. Principal Stresses and Maximum In-Plane Shear Stress
- 9.4. Mohr's Circle—Plane Stress
- 9.7. Absolute Maximum Shear Stress

2. Strain

- 2.1. Deformation
- 2.2. Strain

10. Strain Transformation

- 10.1. Plane Strain
- 10.2. General Equations of Plane-Strain Transformation
- 10.5. Strain Rosettes

3. Mechanical Properties of Materials

- 3.1. The Tension and Compression Test
- 3.2. The Stress–Strain Diagram
- 3.3. Stress–Strain Behavior of Ductile and Brittle Materials
- 3.4. Hooke's Law
- 3.5. Strain Energy
- 3.6. Poisson's Ratio
- 3.7. The Shear Stress–Strain Diagram

10. Strain Transformation

- 10.6. Material-Property Relationships

4. Axial Load

- 4.1. Saint-Venant's Principle
- 4.2. Elastic Deformation of an Axially Loaded Member
- 4.3. Principle of Superposition
- 4.4. Statically Indeterminate Axially Loaded Member
- 4.5. The Force Method of Analysis for Axially Loaded Members
- 4.6. Thermal Stress
- 4.7. Stress Concentrations

5. Torsion

- 5.1. Torsional Deformation of a Circular Shaft
- 5.2. The Torsion Formula
- 5.3. Power Transmission
- 5.4. Angle of Twist
- 5.5. Statically Indeterminate Torque-Loaded Members
- 5.8. Stress Concentration