

**South Dakota School of Mines & Technology**

**MES-770 Continuum Mechanics**  
*Spring 2010*



**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](mailto:Karim.Muci@sdsmt.edu)

**Office Hours**

Monday and Wednesday, 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**

Tuesday and Thursday, 9:30 am – 10:45 am

**Classroom**

CB-205E

**Web Site**

<http://webpages.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**

- Permission of instructor.

**Textbook**

- W. Michael Lai, David Rubin and Erhard Krempel: *Introduction to Continuum Mechanics*. Fourth Edition. Butterworth-Heinemann, 2010.

**Useful References**

- A.I. Borisenko and I.E. Tarapov: *Vector and Tensor Analysis with Applications*. Translated from the Russian by Richard A. Silverman. Dover Publications, 1979.
- Arthur P. Boresi and Ken P. Chong: *Elasticity in Engineering Mechanics*. Prentice Hall, 1987.
- Ansel C. Ugural and Saul K. Fenster: *Advanced Strength and Applied Elasticity*. Fourth Edition.

Prentice Hall, 2003.

- Richard G. Budynas: *Advanced Strength and Applied Stress Analysis*. Second Edition. McGraw-Hill, 1999.
- S. P. Timoshenko and J. N. Goodier: *Theory of Elasticity*. Third Edition. McGraw-Hill, International Student Edition, 1970.

### **Expectations for Incoming Students**

- Students are expected to enter this course with a good working knowledge of:
  - ✓ Basic Solid Mechanics
  - ✓ Basic Fluid Mechanics
  - ✓ Calculus
  - ✓ Vector Algebra and Vector Calculus
  - ✓ Differential Equations

### **Student Effort**

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

### **Course Description (According to the Graduate Catalog)**

Introduction to tensor algebra and calculus. Derivation of kinematic, stress, strain, and thermodynamic field equations governing continuous media. Development of constitutive relations for real materials. Applications to problems in fluid and solid mechanics.

### **Course Objectives**

After taking this course the student should be able to:

- Make correct use of dummy indices, free indices, the Kronecker delta, and the permutation symbol to write equations in the most compact form possible.
- Expand equations given using indicial notation to write them using the conventional engineering notation.
- Work with one or more expressions given in indicial notation to carry out the derivation of formulas.
- Understand the physical meaning of a tensor and of its components with respect to a given coordinate system.
- Successfully apply the following concepts and tensor operations: sum of tensors, product of tensors, transpose of a tensor, dyadic product of two vectors, trace of a tensor, identity tensor, tensor inverse, and orthogonal tensor.
- Understand and successfully apply the transformation law for the Cartesian components of a tensor.
- Successfully apply the following concepts and tensor operations: symmetric and antisymmetric tensors, dual vector of an antisymmetric tensor, eigenvalues and eigenvectors of a tensor, principal values and principal directions of real symmetric tensors, components of a real symmetric tensor with respect to its principal directions, and principal scalar invariants of a tensor.
- Understand the concepts of scalar field, vector field, and tensor-valued function of a scalar,

vector, or tensor field.

- Successfully use the following operations of tensor calculus: gradient of a scalar function, gradient of a vector function, divergence of a vector field, divergence of a tensor field, and curl of a vector field.
- Work with tensors in the following curvilinear coordinate systems: polar coordinates, cylindrical coordinates, and spherical coordinates.
- Understand the concepts of material description, spatial description, and material time derivative.
- Understand and apply the basic equations related to the description of the motion of a continuum.
- Understand and apply the equation of conservation of mass and the compatibility conditions.
- Understand the difference between linear and non-linear strain measures.
- Successfully use linear and some common non-linear strain measures to quantify the deformation of a continuum.
- Understand the concepts of stress vector and stress tensor.
- Understand and apply the equations of motion and the energy equations.
- Understand the difference between linear and non-linear stress measures.
- Successfully use linear and some common non-linear stress measures to quantify the state of stress at a point in a continuum.
- Understand the concept of constitutive equations.
- Understand and apply basic constitutive equations for linear elastic solids.
- Understand and apply the basic constitutive equation for Newtonian viscous fluids.

### Topics

- Introduction to continuum theory.
- Indicical notation.
- Tensors.
- Tensor calculus.
- Kinematics of a continuum.
- Stress.
- The elastic solid.
- The Newtonian viscous fluid (if time allows).

### Computer Usage

- All students must regularly read their SDSM&T e-mail account. During the semester, the instructor may send important information to the students via e-mail.
- For some of the assignments, the students may benefit from using software that has capabilities similar to the ones found in Mathcad, Maple, Mathematica, or Matlab.

### Grading

Exam 1	25 %	
Exam 2	25 %	(comprehensive)
Exam 3 (Final Exam)	25 %	(comprehensive)
Homework	25 %	(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**

Exam	Date	Time	Place
1	Thursday, February 18, 2010	9:30 am – 10:45 am	CB-205E
2	Thursday, April 1, 2010	9:30 am – 10:45 am	CB-205E
3	Tuesday, May 4, 2010	1:00 pm – 2:50 pm	CB-205E

**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 sanctions applicable according to all the rules and regulations currently in force at SDSM&T.

*Note:* According to the graduate 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 two 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 graduate catalog. (Note: In this situation, the student must follow all the guidelines and procedures specified in the graduate 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.

**General Policies**

- Unless specified otherwise by the instructor, all the homework assigned during one week will be turned in the next Thursday 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 assignments is relatively few, it is very important to submit all of them. Missed assignments may severely affect your grade.
- 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.

- 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!
- All the exams will be closed book and closed notes except that a formula sheet consisting of a maximum of 30 equations can be used as long as those equations don't correspond to the solution to a specific problem. If you wish to use this formula sheet you must prepare it yourself and bring it for the exams. Formula sheets will not be provided for those who do not bring their own and cannot be shared. Addition of other information to the formula sheet is not allowed and will be treated as cheating.
- Calculators will typically be required for the exams.
- 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.
- 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. In this event, the entire homework or 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.
- While consulting fellow students outside of the classroom to understand the material is encouraged, each homework 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.
- Near the end of the term 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 team members will receive a grade of zero in all the homework assignments carried out during the semester.
- The grading of an assignment carried out in teams will be influenced by the number of team members.

**Very Important Considerations**

- You must study in detail the theory and solved examples corresponding to all the sections of the textbook related to the topics covered during the lectures.
- You must 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.
- 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.
- Previous experience has shown that students that do not devote enough time every week to study the material corresponding to this course usually have a poor performance during the tests.

**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. Laptop computers can only be used during the lectures for purposes of note taking. Any other uses 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 Graduate 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.