MSE 6602 Tensor Analysis and Mathematical Techniques for Materials
Fall 2012

Textbooks:

M.R. Spiegel: *Advanced Mathematics for Engineers and Scientists*, Schaum's Outline, McGraw-Hill Publishing Company, 1971, ISBN 0-07-060216-6.
R.W. Ramirez: *The FFT, Fundamentals and Concepts*, Prentice-Hall, Inc. 1985, ISBN 0-13-314386-4. (This book is out of print and a substitution is being sought.)
Handouts will be provided.
Other recommended references:
D. C Kay, *Tensor Calculus*, Schaum's Outline, McGraw-Hill Publishing Company, 1988, ISBN 0-07-033484-6.
G. E. Mase, *Continuum Mechanics*, Schaum's Outline, McGraw-Hill Publishing Company, 1970, ISBN 0-07-040663-4.

Instructor: Dr. W. W. Carr
Office: MRDC 4405
Phone: (404) 894-2538; Email: chuck.carr@mse.gatech.edu

Class Hours: 11:00 a.m. MWF; Help Session, if requested via email.

Course Objectives: Students will be introduced to tensor analysis and will learn mathematical techniques for solving problems encountered in materials physics, processing and characterization, particularly involving polymeric fluids and solids.

Main Topics:

I. Cartesian Tensors (approximately 1/3 to 1/2 of class)
II. Laplace and Fourier Transforms I
II. Differential Equations
IV. Partial Differential Equations (PDEs)

Grading: Final grade will be based on highest seven grades

Homework	one grade
Quiz #1 (F 9-07-12)	one grade
Quiz #2 (F 09-28-12)	one grade
Quiz #3 (F 10-31-12)	one grade
Quiz #4 (F 11-21-12)	one grade
Final Exam*	three grades
Drop lowest score	minus one grade
Total	seven grades

* Period 7: December 12, 2012 (Wed) 8:00am - 10:50am.

Homework: Homework exercises will be given to augment lecture notes and will be graded. Each student will be assigned to a problem group composed of four students. It is strongly recommended that each student perform the exercises to better understand the lecture material and as preparation for exams. The group will submit only one homework set that conforms to the problem set rules!!

Quizzes: Quizzes will be given in class at the scheduled time. Exceptions (only for very good reasons) will require making prior arrangements with the instructor.

More Detailed Topics List

I. Cartesian Tensors

Introduction
- Index Notation, Transformation Tensor, Kronecker Delta, Orthonormal Conditions, Definition of a Cartesian Tensor, Permutation Tensor

Tensor Operations
- Inner and Outer Tensor Products

Vector Operations using index notation
- addition and subtraction, scalar or dot product, vector or cross product, gradient of a scalar function of position, divergence of a vector function of position, gradient of the divergence of a vector, curl of a vector function, proofs of vector relationships, Gauss' Theorem, and Stroke's Theorem

Principal Axes for Cartesian Tensors

Maximum Shear Stresses

- Method of Lagrange Multipliers

II. Laplace and Fourier Transforms

Definitions and properties
Transforms for selected functions
Inverse Transforms
Applications

III. Differential Equations

First Order Differential Equations

Linear Differential Equations with Constant Coefficients
- Complementary and particular solutions
- Responses of Maxwell and Voigt Models in stress relaxation, creep and cyclic deformation

Power series solutions

Gamma Functions
- Definition, recurrence formulas and properties

Bessel Functions
- Definition, types and properties
- Recurrence formulas
- Bessel's equation and solutions
- Differential equations with solutions involving Bessel functions

Legendre Functions
- Definition, types and properties
- Recurrence formulas
- Legendre's equation and solution

IV. Partial Differential Equations (PDEs)

- Definitions, types and properties
- Solutions to selected PDEs
- Separation of variables method
- Orthogonal functions