

**Department of Materials Science and Engineering**  
**CER E 416 Ceramic Engineering**  
**Mechanical Properties Laboratory (1 credit)**

**Catalog Description:**

Measurement of the mechanical properties of ceramics: strength, fracture toughness, thermal shock damage. Use of Weibull statistics to characterize strength and failure. Use of SEM fractography to identify defects, microstructure and toughening mechanisms.

**Prerequisites:** None

**Strongly recommended:**

ENGR 170, ENGR 210, ENGR 220, MSE 316 and MSE 317

Please talk to the instructor if you have not taken any one of these courses.

**Textbook and Other Required Material**

1. An Introduction to the Mechanical Properties of Ceramics by Davis J. Green
2. Mechanical Properties of Ceramics by John B. Wachtman, John Wiley & Sons, New York 1996.
3. Supplemental reading material.

**Course Objectives**

1. Students will be able to specify the advantages and disadvantages of ceramics in structural applications.
3. Students will be able to identify the role of processing in controlling the strength of ceramics.
4. Students will be able to mathematically present and analyses the variability in the strength of ceramics and uses strategies to design with materials with strength variability.
5. Students will be able to calculate the stress concentrations due to common flaws and use this to predict the strength of ceramics.
6. Students will be able to evaluate the effectiveness of the various techniques to measure the fracture toughness of ceramics.
7. Students will be able to predict the effect of various toughening mechanisms on the toughness and evaluate their effectiveness
8. Students will be able to evaluate the effect of high temperature, cyclic loading and contact stresses on the mechanical properties of ceramics.
9. Students will be able to conduct laboratory experiments on the mechanical properties of ceramics together with data analysis, consideration for safety, working in teams and written technical presentations.

## Topics Covered

Strength:	Microstructural dependence of strength, fracture origins, fractography.
Statistics of Strength:	Measurement, analysis, designing with strength variability.
Fracture Mechanics:	Effect of flaws, mechanics of failure in the presence of flaws.
Fracture Toughness:	Testing techniques, comparison of the various testing techniques.
Toughening Mech.:	Transformation toughening, crack bridging mechanisms.
High Temp. Props:	Creep of Ceramics, thermal shock
Case Studies:	Examples of structural uses of ceramics.

- Lab 1. Introduction, Safety, Elasticity and Hardness (2 week) Short Lab Format
- Lab 2. Statistics of Strength (1 week) Short Lab Format
- Lab 3. Strength of Ceramics (1 week) Long Format
- Lab 4. Fracture Toughness (2 weeks) Long Format
- Lab 5. Structure and Properties of Advanced Structural Ceramics (1 weeks) Short Format
- Lab 6. Severe Environments (1 week) Short Format

## Class Schedule

one three hour lab weekly

### Contribution of the course to meeting the professional component

This course focuses the students on mechanical properties of ceramics, drawing on their background in structure/property/processing relationships and applying them to specific ceramic systems, tests, analysis and applications. Design concepts are discussed in relationship to ceramic materials case studies. Students with ceramic structural senior projects use the information learned in this course directly in their projects.

### Contribution of the course to program objectives

This course contributes to student abilities in objectives 1 – 6.

### Prepared by:

Rajendra K. Bordia, Associate Professor, October 27, 2000

Revised April, 30, 2001 by Brian Flinn, Research Assistant Professor,