

ME 437/637: Engineering Ceramics, 3 credits, Spring 2023

Instructor: Dr. Fardad Azarmi, Dolve Hall – Office 111D, Phone: 231- 9784
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Office hours: Wednesday 11:00-11:50 AM or by appointment

Lecture: Monday & Wednesday & Friday, 10:00-10:50 AM- Dolve Hall 202

Pre-requisites: ME 223 & ME 331 and admission to professional program.

Textbook: Fundamentals of Ceramics, by Barsoum, Tylor & Francis Publishing, 2nd Edition 2017, New York, ISBN: 9781498708135. (E-Book-Available in course website)

The following textbooks are suggested for students to study:

- *Materials Science and Engineering, 8th Edition, by William D. Callister, Jr., John Wiley & Sons, Inc., 2010.*
- *Materials Selection in Mechanical Design, 3th Edition by M. F. Ashby, Elsevier, “2005.*

Bulletin Description:

Study the crystal and defect structures to determine the electrical and mass transport behaviors in ceramic materials. Investigation on microstructure of ceramic materials and its effect on optical, magnetic, dielectric, and thermo-mechanical properties.

Course Objectives:

The unique combination of physical, electrical, magnetic, and thermo-mechanical properties exhibited by advanced technical ceramics has led to a wide range of applications including automobile exhaust sensors and fuel cells, high speed cutting tool inserts and ball bearings, thermal barrier coatings for turbine engines, and surgical implants. This course examines the crystal and defect structures which determine the electrical and mass transport behaviors and the effects of microstructure on optical, magnetic, dielectric, and thermo-mechanical properties. The influence of these structure-property relations on the performance of ceramic materials in specific applications such as sensors, solid oxide fuel cells, magnets, and structural components is explored.

Course Outcomes:

- Students must understand the concepts of ceramic materials engineering and related vocabularies: *ABET Student Outcomes** (3)
- Students must have an understanding of ceramic engineering topics, e.g., mechanical testing, strengthening mechanisms, and heat treatment: *ABET Student Outcomes** (1 & 6)
- Students must possess an understanding of fundamental structure-property relationships in ceramics: *ABET Student Outcomes** (1 & 6)
- Students must recognize typical materials testing methods for ceramics as accepted industry standards: *ABET Student Outcomes** (6 & 7)
- Students must recognize necessary considerations for informed material selection: *ABET Student Outcomes** (1)

** For the complete list of “ABET Student Outcome” please see pages 4.*

Course Requirements (Updated due to COVID-19):

Communication

- A **Blackboard** site will be maintained for the course and will include all homework, all documents and handouts during lecture, all lecture PowerPoints and overhead slides, any course announcements, and individual grades. **You MUST login regularly and check for announcements and other important information.**
- The posted version of any of these documents will be the official version, superseding any previous versions.
- Your NDSU email address is the official route for communication.
- All quizzes and tests will be a combination of True/False, Complete the Sentence, Multiple Choice, Short Essay, and Work-Out Problems.
- No cell phones or beepers during in-person lectures.
- The instructor holds the right to amend course policies and grade distribution during the semester if needed.

Course & Lecture Policies:

- Each class will generally consist of instruction using PowerPoint and/or overhead slides along with white/black board written notes. Lecture time will also be used for active learning exercises such as group problems, reading quizzes, research breaks, multiple choice assignments, learning games, and review of solutions.
- Late homework or out-of-class exercises: 15% penalty (1 day late), 25% penalty (2 days late), 50% penalty (3 days late) and no credit (after solutions are posted). All homework due dates will be announced in class one week prior.
- If you must miss an examination because of serious illness, family death, etc., notify the instructor or the ME department office (231-8671) as soon as possible and makeup arrangements will be made on a case by case basis. Excuses of a non-urgent nature will not be accepted and failure to take an examination will result in an “F” for that exam.
- Open discussion and questions from the class are encouraged and expected. Problem sets will be assigned for each of the major topic sections. Some of these problem sets will be collected and graded as “Out-of-Class Exercises”. **Lectures will begin Wednesday, January 11th.**

Grading/Evaluation Criteria:

Homework:	15%
In Class Quizzes (4):	35%
Research Project (2):	20%
Final Class Project:	30%

Contract Grades:	≥90%	A
	80-89.9%	B
	70-79.9%	C
	60-69.9%	D
	<60%	F

Tentative Class Schedule:

Lesson #	Reading	Topic(s)
1	Ch 1,1.1-1.2	Course Introduction & Introduction to Ceramics
2	Ch 1, 1.7	Application of Ceramics
3	Notes	Crystal Systems, Directions, and Planes- <i>ME 331. Review</i>
4	Ch 2, 2.1-2.7	Bonding Theory in Ceramics
5	Ch 3	Crystallography and Microstructure of Ceramics
6	Ch 4	Effect of Chemical Force on Properties
7	Ch 6 & Notes	Imperfections in Ceramics
8	Notes	Processing and manufacturing of Ceramics
9	Notes	Processing and manufacturing of Ceramics
10		<i>Introduction of Research Project (1)</i>
11	Notes, Ch 11, 11.5	Materials Selection and Design with Ceramics
12	Notes & Ch 8	Phase Diagrams in Ceramics- Definitions and Basic Concepts- <i>ME 331. Review</i>
13		Presentation-Research Project(1)
14		Presentation-Research Project(1)
15		<i>- Introduction to Final Class Project</i>
16	Ch 9	Glass Structure and Properties
17	Ch 10	Sintering and Grain Growth
18	Ch 11, 11.1-11.4	Mechanical Properties: Fast Fracture <i>Introduction of Research Project (2)</i>
19	Ch 12	Mechanical Properties: Creep, Crack Growth, and Fatigue
20		<i>-Discussion on Final Class Project</i>
21		Report Due Research Project (2)
22	Ch 13, 13.1-13.3	Thermal Properties
	Ch 14, 14.1-14.2	Dielectric Properties
23	Ch 15, 15.1-15.2	Magnetic Properties
	Ch 16, 16.1-16.2	Optical Properties
24		<i>- Course Review</i>
25		Presentation-Final Research Project (Group Presentation)
26		Presentation-Final Research Project (Group Presentation)

*The instructor holds the right to adjust the schedule during the semester if needed.

Technology Issues and Concerns:

- Please contact NDSU Help Desk: Email: ndsuhelpdesk@ndsuhelpdesk.edu, Call: 701-231-8685 (option 1)
- You will need your student ID card if having account issues. CEA Tech Support is available to answer questions or difficulties arising from the operating system or hardware only. Please do not refer questions concerning how to use Creo™ or your homework assignment.

Learning Resources Available:

NDSU Main Library, Dolve Hall 136 Library, www.matweb.com, www.efunda.com, ASM Handbook Online – <http://products.asminternational.org/hbk/index.jsp>

Americans with Disabilities Act for Students with Special Needs

Any students with disabilities or other special needs, who need special accommodations in this course, are invited to share these concerns or requests with the instructor and contact the Center for Accessibility and Disability Resources (www.ndsu.edu/disabilityservices) as soon as possible.

Changes to this course outline may be made if necessary, and will be posted on Blackboard

Veterans and Student Soldiers: Veterans and student soldiers with special circumstances or who are activated are encouraged to notify the instructor in advance (Policy 331.1 Course Syllabus).

Academic Responsibility:

All work in this course must be completed in a manner consistent with NDSU University Senate Policy, Section 335: Code of Academic Responsibility and Conduct. <http://www.ndsu.nodak.edu/policy/335.htm>

Health and Safety Expectations

- Please do not come to class if you are sick. Please protect your health and the health of others by staying home and participate in class remotely. For information on COVID-19, symptoms, testing, and steps to stay healthy see https://www.ndsu.edu/studenthealthservice/covid_19/
- Please carefully read https://www.ndsu.edu/studenthealthservice/covid_19/

ABET Students Outcomes:

1. an ability to identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics.
2. an ability to apply engineering design to produce solutions that meet specified needs with consideration of public health, safety, and welfare, as well as global, cultural, social, environmental, and economic factors.
3. an ability to communicate effectively with a range of audiences.
4. an ability to recognize ethical and professional responsibilities in engineering situations and make informed judgments, which must consider the impact of engineering solutions in global, economic, environmental, and societal contexts.
5. an ability to function effectively on a team whose members together provide leadership, create a collaborative and inclusive environment, establish goals, plan tasks, and meet objectives
6. an ability to develop and conduct appropriate experimentation, analyze and interpret data, and use engineering judgment to draw conclusions
7. an ability to acquire and apply new knowledge as needed, using appropriate learning strategies.