CERAMIC AND REFRACTORY MATERIALS
MSE 474
Fall 2020 Syllabus

MEETING TIMES

Class: 10:15 – 11:15 am MWF Eastern Standard Time
Office Hours: Individual 10-minute blocks from 2-5pm on Mondays

CLASS LINKS

Videoconferencing: Primary: https://msu.zoom.us/j/98349797188 Passcode=MSE474
Emergency Backup: Microsoft Teams (No Passcode)
Learning Management System: https://d2l.msu.edu/.
Copies of the class syllabus, lecture notes, sample problems, etc will be posted here

INSTRUCTOR:

Dr. Jason D. Nicholas
Email: jdn@msu.edu (Please do not send emails via Desire2Learn)

COURSE AIMS:

The primary aim of this course is to help you understand how to engineer the atomic structure, properties and performance of traditional and advanced ceramics. This objective will be met through lectures, tests, and homework.

The secondary aim of this course is to prepare you for future academic or business related endeavors by 1) familiarizing you the R&D process 2) familiarizing you with professional and ethical responsibility and 3) developing your ability to glean and digest relevant information from the literature. These objectives will be met through a tour of a ceramic R&D laboratory, instruction on electronic library databases, an ethical responsibility lecture, and the completion of an article critique.

The tertiary aim of this course **IS TO HAVE FUN!** This will be accomplished through in-class demos, lively class discussions, and interesting/quirky professor behavior.

PREREQUISITES

Required: MSE 260: Electrical, Magnetic, Thermal & Optical Prop. of Materials
Recommended: MSE 370: Physical Processing of Materials
Recommended: MSE 381: Materials Characterization Methods

TEXTS

Official, Required Textbook

Barsoum, M.W. Fundamentals of Ceramics. 1st edition, New York, Taylor & Francis.

Texts on Reserve in the Library

Barsoum, M.W. (2003). Fundamentals of Ceramics. New York, Taylor & Francis. (More or less an updated version of Kingery, Bowen and Uhlmann)

Bloss, D. F. (1994). Crystallography and Crystal Chemistry: An Introduction. Washington, D.C., Mineralogical Society of America.
(A detailed, clear explantion of crystal symmetry)

Boas, M. L. (2006). Mathematical Methods in the Physical Sciences. New York, John Wiley & Sons.
(If you have a math question, Boas has the answer.)

Courtney, Thomas H. (2000), 2nd Ed. Mechanical Behavior of Materials. Boston, McGraw-Hill (Chapter 2 has a good review of elastic properties and tensors)

Doremus, R. H. (1994). Glass Science. New York, Wiley-Interscience.
(The Glass Bible)

Kingery, W. D., H. K. Bowen, and Uhlmann. (1976). Introduction to Ceramics. New York, Wiley-Interscience.
(The Ceramics Bible- A little dated, but extensive.)

Moulson, A. J. and J. M. Herbert (1997). Electroceramics. New York, Chapman and Hall.
(A specialized text for ceramic resistor, conductor, dielectric, capacitor, piezoelectric, pyroelectric, electro-optic, and magnetic materials.)

Ohring, M. (2002). The Materials Science of Thin Films. San Diego, CA, Academic Press.
(The Thin Film Bible)

Rahaman, M. N. (2007). Ceramic Processing. Boca Raton, FL, CRC/Taylor and Francis
(The Ceramic Powder Processing Bible; theoretical emphasis)

ASSESSMENT

Activity	Weight
Class Participation	7%
Virtual Office Hour Attendance	5%
Article Critique	3%
Midterm 1	15%
Midterm 2	15%
Midterm 3	15%
Homework	15%
Final	25%

Percentage Course Grade	4-Point Scale Course Grade
92-100	4.0
87-92	3.5
82-87	3.0
77-82	2.5
72-77	2.0
67-72	1.5
62-67	1.0
<62	0.0

This is more generous than the official conversion at http://inquiry.princetonreview.com/leadgentemplate/GPA_popup.asp

Class Participation

Students are expected to ask questions and get engaged in class activities. That helps make the learning process fun!

Virtual Office Visit

Students are asked to attend 1-10 minute one-on-one meeting with Professor Nicholas each Monday at a consistent, student-selected time between 2-5pm EST. These weekly virtual office visits are a great time for students to ask questions about topics they are curious about, get help with the homework, and help fight the isolating effects of Social Distancing.

Exams

Three midterm exams and a final exam will be administered over the course of the semester. All exams will be open book, open-notes, and are cumulative. Students are

encouraged to produce cheat sheets, prepared only by them, to each of the exams. The exams will be timed events, offered online, during the scheduled class meeting time. It should go without saying that students are expected to complete their exams individually.

Missed Exams
Students missing an exam with either a certified medical excuse or prior instructor approval will take a make-up ORAL examination at a time that is mutually convenient for the student and the instructor. Exams missed without a certified medical excuse or prior instructor approval will be dealt with on an individual basis, in conjunction with the Dean's office. Only one exam can be made up per semester. Note: Make-up exams will not be given to students who take a portion of an exam and then decide to walk-out after they have seen the questions.

Homework Lowest Score Drop
Each students lowest homework score will be dropped. This is to account for the fact that sometimes Prof. Nicholas's questions are not perfectly worded, the fact students have busy lives, etc.

Homework Partners
Homework sets will be assigned through the course of the semester, and students are required to work in groups of two to four people to complete these assignments. Students are responsible for finding their own homework partners. **For each homework assignment, a single problem set should be submitted for each group.** Each of the group's participants will receive the same grade, and each student **IS REQUIRED** to make an equal intellectual contribution to each problem set. **Students ARE NOT allowed to discuss homework problems with anyone other than their homework teammates.**

Homework Format
If writing the homework out by hand, use clean, 8.5" x 11" ruled or engineering paper (typed answers are fine too but all calculations must be shown); show all your work; follow significant figure rules in all problems. state the source of all data used; box all final numerical answers; provide at least a 1" of vertical whitespace between problems. State the name of each homework partner is in the upper right corner of the front page; Present all problems in the order in which they appear in the original assignment; staple all pages together in the correct order; if you need to continue a problem from the previous page please start the new page with a "X continued)" label where X is the problem number.

On-Time Homework Submission
Homework can be electronically submitted via the Assesments>Assignments Menu in D2L. Homework submitted after 10:15 am on the homework due date is subject to a 20% penalty, with an additional 10% penalty per each additional day late. If it's your job to turn in the homework and you are late, so is the homework.

Homework and Exam Solution Sets
Complete homework and exam solution sets will be distributed in class.

Article Critique

Each student will prepare a 2 page critical review of an instructor-assigned peer-reviewed ceramic science article. The format and organizational structure of these article critiques should follow the MSE technical report guidelines posted on Desire2Learn.

Honors Option

Instead of producing an article critique, those taking this course with an Honors Option will be expected to use the Michigan State library electronic tools (Web of Science, SciFinder Scholar, etc.) to produce a 4-8 page review paper on a **pre-approved** ceramics topic of their choosing. This review paper should summarize the current state of knowledge in a particular area, and should cite the most important papers in that area. Students must formulate the review paper content and write the review paper individually. The format and organizational structure of these review papers should follow the MSE technical report guidelines posted on Desire2Learn. Honors College Students must earn a final grade ≥3.0 to receive Honors credit for this course.

ACADEMIC INTEGRITY

Engineers must behave ethically: the safety of the public depends on the competence, honesty, and integrity of engineering professionals. Examples of Academic Dishonesty include:

- Plagiarizing content (Plagiarism is defined as stealing and passing off the ideas or words of another, as one's own. Six or more unreferenced words in a row from another author's work constitutes written plagiarism, as does unreferenced figures)
- Discussing homework with anyone other than your official homework partner
- Cheating on an exam
- Referring to homework solution sets from previous years
- Etc.

Any student caught engaging in unethical conduct will be prosecuted **TO THE FULL EXTENT POSSIBLE** in accordance with the rules set forth in the "All-University Policy on the Integrity of Scholarship and Grades" https://www.msu.edu/unit/ombud/RegsOrdsPolicies.html and will receive a **-100% (negative 100%)** on the assignment. **Repeat offenders will receive a 0.0 in the course.**

CLASS ATTENDENCE

Students missing class are responsible for obtaining notes and/or a verbal summary of the lecture discussion from a fellow classmate. Class notes will be posted on Desire2Learn prior to class, but these are only a basis for discussion.

LECTURE COURTESY

Your respect for the instructor and one another is expected at all times. Please refrain from activities which may disrupt others during class.

INSTRUCTOR COMMITMENT

Students can expect the instructor to be courteous, punctual, helpful, well-organized, enthusiastic, consistent in grading, and available for informal discussions during virtual office hours and immediately before/after class.

TENTATIVE LECTURE SCHEDULE
42, 50 minute classes = 2100 minutes of in-class instruction = 36, 59 minute classes

Date	Topic	Barsoum Reading	Homework Assignments
W 9/2	Lecture 1- Introduction	1.1-1.8	
F 9/4	Lecture 2- Ceramic Materials through the Ages	1.1-1.8	
M 9/7	**No Class- Labor Day**		
W 9/9	Lecture 3- Atomic Bonding Review	2.1-2.9	H1 Assigned
F 9/11	Lecture 4- The Effect of Atomic Bonding on Materials Properties	4.1-4.6	
M 9/14	Lecture 5- Local Atomic Packing Arrangements for Materials with Different Types of Atomic Bonds	3.7	First Office Hours
W 9/16	**No Class- MSU Virtual Engineering Exchange**		
F 9/18	Lecture 6- Crystallography	3.1-3.8	H1 Due H2 Assigned
M 9/21	Lecture 7- Scientific Information Search, Retrieval, and Management		
W 9/23	Lecture 8- Bulk Ceramic Thermodynamics, Ellingham Diagrams	5.1-5.9	H2 Due H3 Assigned
F 9/25	**No Class-Prof. Nicholas Out of Town**		
M 9/28	Lecture 9- Bulk Ceramic Phase Equilibria	8.1-8.7	
W 9/30	Lecture 10- Nano-Particle Phase Equilibria		H3 Due H4 Assigned
F 10/2	Lecture 11- Introduction to Crystalline Defects	6.1-6.5	
M 10/5	Lecture 12- Point Defect Equilibria	6.1-6.5	
W 10/7	Lecture 13- Bulk Controlled Electrical Conduction	5.5, 7.1-7.6	H4 Due H5 Assigned
F 10/9	Lecture 14- Diffusion, Electrochemical Potentials	7.1-7.6	
M 10/12	Lecture 15- Midterm 1 Q&A Session		
W 10/14	Lecture 16- Midterm 1 on Lectures 1-10, Homework 1-4		
F 10/16	Lecture 17- Electrochemical Ceramic-Based Devices I	14.1-14.8 7.1-7.6	
M 10/19	Lecture 18- Electrochemical Ceramic-Based Devices II		
W 10/21	Lecture 19- Interface Controlled Electrical Conduction	7.1-7.6	H5 Due H6 Assigned
F 10/23	Lecture 20- Glasses & Amorphous Ceramics I	9.1-9.6	
M 10/26	Lecture 21- Optical Ceramics	16.1-16.8	
W 10/28	Lecture 22- Dielectric Ceramics I	14.1-14.8	H6 Due H7 Assigned AC Assigned
F 10/30	Lecture 23- Dielectric Ceramics II	14.1-14.8	
M 11/2	Lecture 24- Magnetic Ceramics I	15.1-15.8	
W 11/4	Lecture 25- Midterm 2 Q&A Session		
F 11/6	Lecture 26- Midterm 2 on Lectures 1-19, Homework 1-7		

M 11/9	Lecture 27- Multiferroics, Bioceramics, Superconductivity	15.1-15.8 10.1-10.6 12.1-12.3	
W 11/11	**No Class- Veteran's Day, Prof. Nicholas at Ohio Fuel Cell Coalition Workshop**		
F 11/13	Lecture 28- Mechanical Properties of Ceramics I	11.1-11.6 12.3-12.6	H7 Due H8 Assigned
M 11/16	Lecture 29- Mechanical Properties of Ceramics II	13.1-13.7	
W 11/18	Lecture 30- Fracture Toughening Mechanisms, Ceramic Composites I: CMCs, Metamaterials and Heterojunctions	11.1-11.6 12.3-12.6	
F 11/20	Lecture 31- Ceramic Composites II: Concrete		
M 11/23	**No Class- Thanksgiving Week**		
W 11/25	**No Class- Thanksgiving Week**		
F 11/27	**No Class- Thanksgiving Week**		
M 11/30	Lecture 33- Midterm Q&A Session		
W 12/2	Lecture 34- Midterm 3 on Lectures 1-28, Homework 1-7		
F 12/4	Lecture 32- Student Choice Lecture		
M 12/7	Lecture 35- Review Jeopardy, Student Feedback, SIRS		
W 12/9	Lecture 36- Course Themes Overview, Final Exam Q&A Session		H8 Due AC Due
F 12/11	**No Class- MSU Design Day**		
F 12/18	7:45-9:45 am Final Exam on All Lecture, All Homework		
Tu 12/22	*Grades Due to Registrar*		

H=Homework, AC=Article Critique