EMAT 552: Advanced Ceramics
(Revised 9/02/13)

**CATALOG DATA:**
EMAT 552 – Advanced Ceramics: F 3 credits (3 lecture)
Advanced treatment of ceramic materials including phase transformations, defect chemistry, thermodynamics, synthesis/processing, sintering theory, grain growth, and characterization. Emphasis is placed on functional properties of oxide ceramics for applications in energy conversion.

**TEXTBOOK:**
*Ceramic Materials: Science and Engineering*; C. Barry Carter and M. Grant Norton; Springer (2007)

Additional non-required reference textbooks:


**INSTRUCTOR:**
Dr. Stephen W. Sofie, Roberts 201E, 994-6299, 994-6292 (fax), ssofie@me.montana.edu
Office Hours: As posted outside of my office or any time my door is open.
The use of e-mail is encouraged outside of office hours

**E-MAIL POLICY:**
According to MSU policies and procedures, the myMSU portal (student.name@myportal.montana.edu) is the official university means of communication with students. Students are expected to check their email no less frequently than twice a week in order to stay current with University-related communications. Students have the responsibility to recognize that certain communications may be time-critical. Failure to check for messages and failure to receive messages due to full mailboxes or auto-forwarded email are not acceptable excuses for missing official University communications. Students may auto-forward email to an outside email client at their own risk.

**ENTRANCE EXPECTATIONS:**
This course is designed to complement the students’ knowledge on classical mechanics by incorporating the fundamentals of materials at the atomic level forming the foundation of tailorable properties and how that applies to the design process. The student is expected to have a working knowledge of materials science, physics, and mathematics.

**PREREQUISITES:**
For ME Students: EMAT 251, EMAT 252, EMAT 350
For COE Students: Consent of instructor
For Students outside of COE: Consent of instructor
COURSE OBJECTIVES:
While materials science and engineering concepts are relevant to all classes of materials, advanced ceramic materials have become the backbone of many modern technologies; including fuel cells, batteries, ferroelectrics, piezoelectrics, superconductors, nano-scale sensing/actuation, noble metal free catalysis, selective ion membranes, photovoltaics, and biomedical drug delivery/implant technologies. These multi-functional materials systems are currently being researched across the MSU campus in the COE, Physics, Chemistry, and Land Resources. The mechanisms by which these functional ceramics draw upon their properties are essential to the Mechanical/Materials Engineer, Solid State Physicist, and Inorganic Chemist to further applications and devices built upon these materials by understanding how functional properties may be manipulated through chemistry and processing. Further, manipulating one material property may have unintended consequences for other material properties, and the engineer needs to have the depth of understanding to be aware of these trade-offs. EMAT 552 will provide the graduate student an in-depth understanding of ceramics including topics in phase equilibria, crystallography, and phase transformations; defects and thermodynamics (Kröger-Vink Notation); electrical and ionic transport behavior; Brouwer/Ellingham diagrams; sintering theory, grain growth, and characterization methodology.

COURSE OUTCOMES:
Upon completion of this course, students will have demonstrated the ability to:
• Calculate intrinsic defect concentrations in ceramic oxide systems.
• Define defects in crystalline ceramics and mechanisms of charge compensation.
• Explain the mechanisms of diffusion that drive both coarsening and densification in the sintering and grain growth process.
• Predict electrical and ionic conduction in oxide materials.
• Apply Pauling’s rules to the formation and stability of ceramic atomic structures.
• Understand the fundamental operation of XPS, XRD, and thermal analysis characterization.

CLASS SCHEDULE:
TBD – posted on D2L

ASSESSMENT AND EVALUATION:
The course outcomes will be evaluated, and the final letter grades will be based, on the following criteria:

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<tr>
<th>Component</th>
<th>Weight</th>
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<tr>
<td>Homework &amp; In-class Participation</td>
<td>20%</td>
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<tr>
<td>Midterm Exams (3 total)</td>
<td>80%</td>
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Note: no grading curve will be employed and students’ final grades are not based on the respective performance of peers

Examinations missed due to unexcused absences cannot be made up except in highly unusual cases. If you know in advance that you must miss any exam, notice must be made PRIOR to the week of the exam and options will be discussed with you. Three equally weighted
midterms will be administered during the course of the semester. Homework assignments are
due in one week from the assignment date, unless otherwise noted. Late homework
assignments will not be accepted for credit towards the final grade.

Point totals required to receive a particular letter grade will be assigned according to the chart
below. Plus and minus grading will be used at the discretion of the instructor. Inappropriate
conduct, late arrival to lecture, poor group performance, and cheating/plagiarism will affect
the final grade.

A: 90 – 100%
B: 80 – 90%
C: 70 – 80%
D: 60 – 70%
F: <60%

The course objectives may be evaluated by means of midterm and semester end surveys in the form
of an un-graded quiz and/or questioner.

Course Web Site:
All course information will be provided through Desire 2 Learn (D2L) https://ecat.montana.edu/
Course information including schedule, homework/test solutions, exam study guides, and project
guidelines will be posted on the D2L course website throughout the semester

Special Needs Information:
Students with special needs or requiring special accommodations should contact the instructor
or the campus Disabled Student Services Office at the earliest opportunity.

Student Conduct:
Students are expected to conduct themselves in accordance with the MSU Student Conduct
Guidelines (http://www2.montana.edu/policy/student_conduct/), including the areas of
academic honesty, behavior, and responsibilities.