OFFICIAL COURSE DESCRIPTION:
The course focuses on the principal materials fields that are satisfied by ceramic materials. The topics covered by this course go well beyond those covered in Introduction to Materials Science and Engineering 14-635:203. These topics include traditional areas such as whitewares, enamels, glazes, glass and refractories. In addition a wide range of advanced materials topics include electronic, magnetic, optic, biomedical, catalyst and structural materials. An emphasis will be placed on understanding the interrelationship between chemistry, structure, properties and performance.

14-635:360 COURSE TEXT:
Required Text : 
Price: $286.00, ASM Member*: $228.00  shipping and handling $12.00 + additional volumes $3.00
* Members of Materials Advantage™ receive the discount price.

Scheduled Official FINAL EXAM (Full Semester Material)
Noon – 3:00 PM --- Friday, 07 May 2010 – (tentative)
Final Exam date subject to change with consensus of class

Students may, by request, have reasonable extra time for the Midterm and Final

Optional, Voluntary, Group Review Sessions (after class) - Dates (tentative):
Midterm Exam Review - Tuesday, 09 March + ?
Midterm Answer Review - Tuesday, 22 March
Final Exam Review - Reading Day?

Course Format:
The course is in an interactive lecture/recitation format.

Assessment of Outcomes:
Student progress is assessed by mid-semester and end-of-semester examinations. Progress is monitored by recitation questions, spot quizzes (verifying attention to readings) and real-world problem solving/applications via hand-in assignments. Course outcomes are assessed formally through the examinations, recitation interaction and student evaluation forms.

Relationship to Program Objectives:
The course provides contributions to program objectives 1 - 4. With respect to general ABET proficiencies it contributes significantly to (a), (b), (c), (e), and (i) as they pertain to ceramic-metal systems and to firing. Items (f), (g) and (h) are stressed through real world examples and examples in which other knowledge may contribute to solving engineering problems in ceramic-metal systems. The nature of multi-disciplinary teams (item d) in both areas is discussed briefly. As a vital part of ceramic-metal systems technologies, of ceramic firing and of refractories and cements, the relationships between processing, structure, properties and performance { SP3 } are stressed in
choosing amongst production methods, optimizing production variables and selecting materials or a materials system.

Final Grade (Spring 2010)
The credit formula followed per student vote at the organizational meeting (no subsequent “veto”):

- Up to 2 points per Summary (0, ½, 1, 1½, 2 pt)* - 28 pts. {28% of grade}
- ¼ point for attending class** - 7 {7% of grade}
- Up to 35 points for Midterm Exam (35%) - 25 {25% of grade}
- Up to 45 points for Final Exam (45%)*** - 40 {40% of grade}

TOTAL 100 pts. {100% of grade}

* A summary of the prior week’s readings and lectures is due at the Tuesday class immediately following. A summary furnished after the Monday class due date and at or before the following Thursday class will receive 1 point. No points will be given for further lateness. Points will be deducted for an incomplete summary or outline.

The summary may be either:
- A detailed written summary, for each topic (based on course notes, handouts, visuals & lecture) or
- A revised set of notes developed from the lectures, and text plus: visuals and handouts.

** Acceptable absence excuses: documented illness, professional travel, family loss, Dean’s excuse …

*** I reserve the right to count the all-inclusive Final Exam at more than 40%, if a student excels. The formula above may be supplemented or altered to include quizzes, additional exercises, etc.

Tentative SPRING 2010 SCHEDULE Tentative

WEEK 1 - Tuesday / Thursday, 19 / 21 January
A« Introduction to Ceramics & Glasses 693 - 706
    Traditional Applications for Ceramics 710 - 731
B« Processing of Ceramic Powders 732 - 754

WEEK 2 - Tuesday / Thursday, 26 / 28 January
A« Characterization of Ceramic Powders 754 - 762
B« Forming and Predensification 763 – 783

WEEK 3 - Tuesday / Thursday, 02 / 04 February
A« Drying, Densification – Vitrification, Furnaces 785 - 789
B« Densification – Sintering, Pressure Sintering, SHS 789 - 808

WEEK 4 - Tuesday / Thursday, 09 / 11 February
A« Densification – Grain Growth Control, Non-Traditional Processes 802 - 822
B« Final Shaping and Surface Finishing 823 – 845

WEEK 5- Tuesday / Thursday, 16 / 18 February
A« Joining - Basic Principles, Ceramic-Metal Joining 846 - 855
B« Joining - Basic Principles, Ceramic-Metal Joining 855 - 864

WEEK 6- Tuesday / Thursday, 23 / 25 February
A« Testing and Characterization - 865 - 904
WEEK 7 - Tuesday / Thursday, 02 / 04 March
A« Crystallography and Engineering Properties of Ceramics  
B« Engineering Properties of Metal-Oxide & Toughened Ceramics

Optional Review Session - Date/Time TBD

WEEK 8 - Tuesday / Thursday, 09 / 11 March
A« Engineering Properties of Multicomponent & Non-Oxide Ceramics
B« MIDTERM EXAM - Covers Material through Week 7 - MIDTERM EXAM

WEEK 9 - Tuesday / Thursday, 23 / 25 March
A« Advanced Structural Ceramics - Design
B« Advanced Structural Ceramics – Strength and Wear Applications

WEEK 10 - Tuesday / Thursday, 30 March / 01 April
A« Advanced Structural Ceramics – High Temperature Applications
B« Electrical &Electronic Applications – Insulators and Dielectrics

WEEK 11 - Tuesday / Thursday, 06 / 08 April
A« Electrical &Electronic Applications – Electronically Active Ceramics
B« Electrical &Electronic Applications – Sensors, Thermistors, Varistors, LTSC

WEEK 12 - Tuesday / Thursday, 13 / 15 April
A« Magnetic Ceramics – Principles & Recording Devices
B« Magnetic Ceramics – Transformers, Actuators, Sensors + Handout

WEEK 13 - Tuesday / Thursday, 20 / 22 April
A« Ceramic Matrix Composites
B« Carbon – Carbon Composites

WEEK 14 - Tuesday / Thursday, 27 / 29 April
A« Biomedical Applications Handout
B« Metallization & Enameling Handout

FINAL EXAM (Full Semester Material)
Scheduled for: 10:30AM – 1:30 PM Wednesday 09 May 2010
(Final may be rescheduled by arrangement and with full participant consensus.)

This MSE of Ceramics & Glasses Spring 2010 Syllabus may not be altered in any way without the expressed, signature permission of V.A. Greenhut

**Materials Science & Engineering of Ceramics and Glasses, 14-635:360, SPRING 2010 SYLLABUS (cont.)**

**Materials Science and Engineering of Ceramics & Glasses** 14:635:360

[Official DEPARTMENT SYLLABUS ---- ARIAL BOLD =Material Included in Syllabus for Spring 2010]

**Required Text:**  *Ceramics and Glasses, Volume 4, Engineered Materials Handbook,*

Ed. S. Schneider, ASM Int, Materials Park  (1991) 1217 pages

**Grade Basis:**

- 2 hourly exams = 25%
- Final Exam = 35%
- Homework, attendance and quizzes=15%

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### Course Outline

<table>
<thead>
<tr>
<th>Week</th>
<th>Title</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Introduction</td>
<td><strong>Scope of course, general usage, and properties warranting interest</strong>, forms (film, single crystal, powder, etc.) and <strong>microstructures of ceramics</strong>, scattering as a differentiator, <strong>processing methods</strong></td>
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<tr>
<td>2.</td>
<td>Whitewares</td>
<td><strong>Composition and porosity microstructures</strong>, triaxial diagrams, vitrification, classes and functions</td>
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<tr>
<td>3.</td>
<td>Porcelain Enamels and Glazes</td>
<td><strong>Definitions, compositions, functions, microstructures</strong> (1/2 lect.)</td>
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<tr>
<td>4.</td>
<td>Glass</td>
<td><strong>Vitreous state definition</strong>, compositions, processing methods, principal products</td>
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<tr>
<td>5.</td>
<td>Refractories</td>
<td>Applications, key compositions, microstructures, applications in metallurgical and glass manufacturing</td>
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<tr>
<td>6A.</td>
<td>Hourly 1</td>
<td></td>
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<tr>
<td>6B.</td>
<td>Electronic Ceramics [ 1 week ]</td>
<td><strong>Insulators and electronic substrates</strong>, property requirements and processing, automotive and computer applications</td>
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<tr>
<td>7.</td>
<td>Electronic Ceramics [ 1 week ]</td>
<td><strong>Ion and Metallic Conductors</strong>, compositions, concept of charged carrier conc and mobility, applications in electrochromic, gas sensing, PTCR, varistor, and battery materials</td>
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<tr>
<td>8.</td>
<td>Electronic Ceramics [ 1 week ]</td>
<td><strong>Dielectrics, structure-properties</strong>, single crystals and polycrystals, Piezoelectrics, structure-properties, single crystals and polycrystals, Electrostriction, structure-properties, single crystals and polycrystals,</td>
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<tr>
<td>9.</td>
<td>Magnetic Ceramics</td>
<td><strong>Ferrimagnetic ceramics</strong>, concept of hysteresis and contrast to ferromagnetism, <strong>compositions, microstructure</strong>, role of processing atmosphere, applications</td>
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<tr>
<td>9.B</td>
<td>Optical Ceramics</td>
<td><strong>Transparent Ceramics, microstructure</strong> and electronic band structure requirements, v-curve, RATS law, <strong>spinels, ALON, YAG, Glass-Ceramics, glasses</strong></td>
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<tr>
<td>10.</td>
<td>Optical Ceramics</td>
<td>Nonlinear Optical Materials, refractive, birefringent, linear, quadratic, compositions, single crystals, films, hybrid materials</td>
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<tr>
<td>11.</td>
<td>Optical Ceramics</td>
<td>Luminescent Materials, electronic band structure, optical up-conversion and down conversion, scintillation, optical amps, lasers, taggants, long afterglow, PET detectors and electroluminescent</td>
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<tr>
<td>12A.</td>
<td>Biomaterials</td>
<td><strong>Hard tissue models, Inert, bioactive and resorptive materials, compositions and microstructures</strong></td>
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<tr>
<td>12B.</td>
<td>Hourly Exam II</td>
<td></td>
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<tr>
<td>13.</td>
<td>Chemically Bonded Ceramics</td>
<td><strong>Mechanisms of bonding, Compositions, applications for biomaterials and architectural products</strong></td>
</tr>
</tbody>
</table>
| 14. | **Structural Ceramics**  
[Biomaterials] | **Single phase, transformation toughened**, carbon fiber composites, fiber glass, **metal matrix composites**, and **ceramic matrix composites** |