Math of Materials Syllabus

YEAR COURSE OFFERED: 2015

SEMESTER COURSE OFFERED: Spring 2015

DEPARTMENT: Mathematics, Comp. Sci. and Coop. Engineering

COURSE NUMBER: Math 4393 A

NAME OF COURSE: Special Topics: Math of Materials
Monday-Wednesday 10:10 – 11:00
Online Reading and Discussion Fridays

NAME OF INSTRUCTOR: Dr. Mary Flagg
flaggm@stthom.edu
713-525-3187
216 Math House

OFFICE HOURS: Monday and Wednesday 11:30 – 1:30
Tuesday 2:00 – 4:00
Thursday 2:00 – 3:00 Or by appointment

The information contained in this class syllabus is subject to change. Students are expected to be aware of any additional course policies presented by the instructor during the course.

Course Description

Materials Science is the study of the properties of materials. Classically, materials science was thought of as the study of metals, alloys and composites used by engineers to build modern structures. However, materials science encompasses all materials, from the proteins in your body to the turbine blade in a jet engine. The subject is vast and the possibilities are limitless. Mathematics plays a key role in modern attempts to model the structure and movement of materials under differing conditions. Modern modeling techniques involve advanced mathematics, much at a graduate level. Yet undergraduates should be introduced to the exciting career possibilities available. Therefore, this course uses undergraduate level math and simplified models to explain the basic concepts of materials science.

This course is a problem solving course. Students will work on simple models in the areas of algebra, geometry, linear algebra, calculus, differential equations and probabilistic methods. Groups of 2-4 will then choose one topic to work on in more depth. Class time at the end of the semester will support the chosen projects and show examples of current research projects in the field.

Students will be expected to be familiar with basic linear algebra and differential equations.
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Required Reading

There is no required textbook for this class. Students will be given access to the instructor’s notes and other resources through Blackboard.

Learning Outcomes

1. Students will be able to explain the fundamental principles of materials science.
2. Students will learn the principles of mathematical modeling and develop simple models to explain the structure of materials.
3. Students will classify models by the mathematics, length scale and time scales involved. They will explain the assumptions inherent in the models.
4. Students will realize that new techniques and new mathematics needs to be developed to meet the challenges of modeling materials.
5. Students will sample current questions under investigation in current research, challenging them to delve deeper into the mathematics of their choice.

Major Assignments/Exams

Grades will be based on class participation, problem sets and the group project report and presentation.

<table>
<thead>
<tr>
<th></th>
<th>Percentage</th>
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<tbody>
<tr>
<td>Class Participation</td>
<td>10%</td>
</tr>
<tr>
<td>Problem Sets</td>
<td>60%</td>
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<tr>
<td>Group Project</td>
<td>30%</td>
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Grading Scale If your average is “x”

<table>
<thead>
<tr>
<th>Grade Letter</th>
<th>Minimum to Maximum</th>
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<tbody>
<tr>
<td>A</td>
<td>90 ≤ x ≤ 100</td>
</tr>
<tr>
<td>B</td>
<td>80 ≤ x &lt; 90</td>
</tr>
<tr>
<td>C</td>
<td>70 ≤ x &lt; 80</td>
</tr>
<tr>
<td>D</td>
<td>60 ≤ x &lt; 70</td>
</tr>
<tr>
<td>F</td>
<td>x &lt; 60</td>
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Classroom Etiquette

Class Attendance is mandatory. Students are expected to attend class regularly and participate in the discussions. Students will be expected to share their solutions with the class. Right answers are not the point, sharing the thought process and problem solving techniques are the essential outcomes of student problem solving. Some of these problems may not have definite answers. Please turn your cell phones to silent during class.

Accommodations

The University of St. Thomas abides by the Americans with Disabilities Act and Section 504 of the Rehabilitation Act of 1973, which stipulates that no student shall be denied the benefits of an education "solely by reason of a handicap." If you have a documented disability that may impact your performance in this class and for which you may require accommodations, you must be registered with and provide documentation of your disability to Counseling and Disability
Math of Materials Syllabus

Services which is located on the second floor of Crooker Center. Contact Debby Jones at 713-525-6953 or Rose Signorello at 713-525-3162.

Blackboard Resources

This course will be managed with Blackboard. You may find the login for blackboard on your My StThom page. Use your CELT login ID and password to access blackboard. Course syllabus, calendar, reminders, announcements and discussions will be found in Blackboard. **Reading assignments will be placed on Blackboard in place of meeting on Fridays.**

List of discussion/problem topics

Geometry for Materials
- Sphere Packing, Regular Polyhedra and Crystals

Algebra for Materials
- Crystal Lattices
- Symmetry Groups, Rotations and Quaterions
- Grain Misorientation
- Stress Tensors
- Stress and Strain

Analysis for Materials
- The calculus of variations introduction

Differential Equations for Materials
- Spring Model of Growth
- Mullins-Sekerka Instability - Growth of a Solid in a Liquid
- Molecular Dynamics and Carbon Nanotube Modeling

Probabilistic Models for Materials
- Potts Model for Grain Growth

Current Research – Presentations from the Park City Math Institute Summer School on the Math of Materials in July of 2014

**Important Academic Dates for Spring 2015**

<table>
<thead>
<tr>
<th>Event</th>
<th>Date</th>
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<tbody>
<tr>
<td>First Class Day</td>
<td>January 12</td>
</tr>
<tr>
<td>Last Day to Add a Course</td>
<td>January 20</td>
</tr>
<tr>
<td>Martin Luther King Day</td>
<td>January 19 NO CLASSES</td>
</tr>
<tr>
<td>Last Day to drop without academic penalty</td>
<td>January 28</td>
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<tr>
<td>Spring Break</td>
<td>March 9=14</td>
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<tr>
<td>Last Day to drop with a “W”</td>
<td>April 17</td>
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<tr>
<td>Easter Break</td>
<td>April 2-5</td>
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<tr>
<td>Last Day of Classes</td>
<td>May 2</td>
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